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Civil Engineering.

Cost of Transportation on Railroads. By CHARLES ELLET, Jr., C. E.

(Continued from Vol. VI, page 370.)

I propose now to continue to produce those details of the cost of transportation on railroads, which enter into the approximate formula for the computation of the average annual charges, preparatory to the indication of certain modifications, which, in time, will be found necessary, in order to adapt the expression more strictly to the various cases which occur in practice. A reference to the table contained in a previous number of this journal, (vol. vi. p. 323) will show with what accuracy the formula, in its present state, applies to almost every variety of roads in the Union.

But it will occur to the experienced reader, that there are certain sections of the country on which the cost of fuel is exceedingly light; others where it is very great; that there are some lines provided with a double track; some on which the engines are unusually large, or on which the company are exposed to peculiar causes of expenditure. It will be readily conceded, therefore, that a formula *strictly* applicable to all these cases, ought to be expressed in more terms than the mere length of the line, the tonnage, the travel, and the miles run by the locomotive engines—which are all the quantities that appear in the rule which has been presented. But yet we have seen that that formula, as it is, does apply and give consistent results, and results quite close enough for almost any useful practical purpose, without any correction for these varying conditions. This circumstance, therefore, needs explanation; but before explanation can be advantageously

offered, I must lay before the reader certain details which have been used in the construction of the formula. In anticipation of this explanation, however, I may observe that the true cause is, that these circumstances, which disturb the action of the general law, have very little influence compared with the value of the great items which compose the formula. I shall return to this subject again; but at present we may proceed with the determination of the values of the detail of expenses, and leave the slight corrections to be applied in consequence of these irregularities—irregularities chiefly in the prices of labor and materials—for the sequel. The reports of the various companies for the current year, will shortly be published; and by introducing the results which it is to be presumed they will exhibit, under an improving system of economy, I hope to be able to make a still closer approximation to the truth. We shall have also, in a few weeks, the results of the year's operations on the Philadelphia and Reading Railroad, from which we shall be able to verify experimentally, the influence on the cost attributable to a very large trade conducted under remarkably favorable circumstances.

I propose to consider next—

The Cost of Fuel.—It is obvious to every one that the *consumption* of fuel depends on the construction and power of the engine, the gradients of the road on which it operates, and the load which is conveyed. The *cost* of fuel really depends, in some measure, on these circumstances, but chiefly, in practice, on the *price* of wood; for in this country the price of a cord of wood is much more variable than any other element which affects the value of fuel, or the value of motive power.

The following table of the distance run by locomotive engines in different parts of the country, together with the annual aggregate expense of fuel, and the reduced expense, per mile run, will serve to exemplify this point.

TABLE of the Expense of Fuel.

Name of Road.	Year.	Distance run by engines in miles.	Expense of fuel.	Cost of fuel per mile.	Remarks.
Georgia Road,	1842	152,873	$ 6,405	4.2 cts.	South'n Roads, Average 5 cts.
Central Road,	1842	102,145	4,810	4.7	
South Carolina Road,	1842	260,324	13,950	5.3	
Portsmouth and Roanoke,	1842	96,000	4,700	4.9	
Petersburgh Road,	1842	131,160	8,200	6.2	
Baltimore and Ohio,	1843	509,765	33,547	6.6	Roads in Middle States, Average 9 cts.
Baltimore and Susquehanna,	1842	128,349	8,981	7.0	
Utica and Schenectady,	1841	155,828	11,000	7.1	
Philadelphia and Columbia,	1842	261,744	22,000	8.4	
New York and Erie,	1842	24,564	2,744	11 1	
Reading Road,	1842	198,055	19,002	9.6	
Norwich and Worcester,	1842	144,321	14,662	10.2	New England Roads, Average 13 cts.
Western Road,	1842	397,295	50,774	12.8	
Providence Road,	1842	120,000	17,548	14.6	

[NOTE.—The expense of fuel on the New York and Erie Road, includes the cost of sawing, and the loading of the tenders. The

engines on this road, as well as some of those on the Reading and Western Roads, carry very heavy freight trains.]

On inspecting this table we observe that the cost of fuel for each mile traveled by the engines, increases very uniformly as we proceed from south to north. We know, also, that the price of wood likewise increases on the route, though not precisely in the same proportion. Wood is worth, on the average, two and a half times as much in New England as it is in Georgia—but there are roads in New England on which the expenditure for fuel is from three to four times as much as it is on some of those in Georgia. This inference is not wholly attributable to variations in price, but depends, in part, on the size of the engines, and the magnitude of the trains conveyed. The engines on the southern roads, are, in general, not quite so heavy, nor so heavily loaded, as those used on several of the northern lines—a circumstance which somewhat, though not very materially, influences the result. Waiving the influence of this consideration, and regarding the engines as of nearly the same average weight on all these lines, this table will supply us at once with a correction to the formula, which we may apply when we desire to approximate more closely to the actual expenses.

The formula, for computing the aggregate annual expenses of a railroad, is based on an average cost of fuel of 9 cents per mile run.

In making the application, from year to year, we shall find that the results which it supplies will need to be modified, and that this modification will be equal to an addition of 4 cents per mile run for the New England roads, and a reduction of 4 cents per mile run for the Southern roads.*

Wages of Train Hands.—It is the practice of many companies to include the wages of enginemen, firemen, conductors, breakmen, &c. in the item of fuel and salaries; of others to combine them with oil and repairs of engines and cars. Indeed, the heterogeneous mixture of items, which are presented to the public in a lump, cannot but lead sometimes to the conclusion that it is the object of the report to conceal the simple truth. It cannot be supposed that any company mingle such dissimilar items together in their own books; and as it is really easier to copy off the items under their separate heads, than to add them together and present them in a mass, it must be supposed that the object of the condensation of matter is to prevent an intimate acquaintance with their affairs. This inference is strengthened, in my estimation, by the fact that the accounts of those companies which pursue this course, exhibit an annual, and sometimes vast, augmentation of capital. By keeping the items concealed, the public are forbidden from ascertaining what portion of the ordinary current charges go to swell the annual charge to construction, and the deception is thereby practiced longer with impunity. There are certainly some remarkable exceptions which might be named as good models for imitation. The accounts of the Georgia Road are always presented

* I propose to present, in a future number, a more accurate and general formula for the determination of the consumption of fuel.

with clearness and accuracy; and though they might be greatly improved by the addition of the net and gross tonnage, and travel conveyed one mile, they exhibit, in their present state, a much better appreciation of the importance of knowing the precise and detailed condition of their business, than is observable in the statements of other similar institutions.

The report of the Baltimore and Ohio Company, for the current year, also stands out conspicuous amidst the general confusion; and, as ought to be expected, *every item* of expenditure on that line compares advantageously with the corresponding item on any other road in the country.

The directors of the Norwich and Worcester Road, have published a table which might be made valuable, but it is actually rendered almost useless for want of the amount of the business transacted. The number of tons of goods, and the number of passengers conveyed one mile, ought to have been stated, and the different classes of wages should have been separately given. It is of little use to tell us the exact amount of expenses incurred in the transportation of freight without informing us of the amount of freight transported.

The directors of the Western Road have also produced much valuable detail; but they have failed to present the item of "services" under appropriate heads. No correct judgment can be formed of the economy of the administration of a line on which the salaries of agents and superintendents, president and engineer, train-hands and wood-cutters, clerks and ticket-men, are condensed into one total. The separation of this column—the accurate addition of the number of passengers carried one mile, and the *quantities* of each sort of fuel consumed—would render the report of this company a most valuable document. I trust that they will not be deterred from continuing this detailed exhibition of their affairs, when their road and machinery begin to manifest some of the effects of time and use.

In consequence of this mingling of items, I am unable to separate, with the desirable precision, the sum paid on many roads for wages to the engine-hands, from that paid to the conductors and breakmen. For this reason I find it convenient to include the wages of all the train hands in the item of locomotive power. This item must, accordingly, be expected to vary with the magnitude of the train, and, somewhat, with the acclivities of the gradients: heavier gradients and the larger trains requiring usually a greater number of breakmen. The variations consequent on this cause, are, however, very small; and we will come exceedingly near the truth by this formula,

$$7\tfrac{1}{2}+\frac{t}{25}$$

for the value of the wages to the train hands, in cents, for each mile traveled by the train—t standing for the average number of tons of freight in each train. The correctness of this approximation will be seen by a glance at the following table.

TABLE.

Name of Road.	Year.	Miles run.	Wages to train hands.	Wages per mile.	Remarks.
Reading Road,	1841	83,717	$ 5,785	7.0	With moderate trains.
Reading Road,	1842	198,055	17,752	9.0	With heavier trains.
Boston and Providence,	1842	132,229	10,799	8.0	Medium trains.
Baltimore and Ohio,	1843	509,765	31,161	6.1	Light trains and heavy grades.
Eastern Road,	1842	184,127	14,774	8.0	The trains on both these roads are moderate.
Georgia Road,	1842	152,873	12,666	8.3	
Petersburgh Road,	1841	131,160	14,558	11.0	The Petersburg road was worked at disadvantage in 1840 and '41. The freight trains on the N. Y. & Erie road are unusually large.
New York and Erie,	1842	24,564	2,814	11.5	

The average value of wages, excepting for roads on which the trains are excessively large, may be safely and justly assumed at 8 *cents per mile run.*

Oil and Tallow for Engines.—The expense of oil is certainly a very small matter, when compared with the aggregate yearly charges against a railroad company; but it is a very important matter for every company to know exactly what this, and every other item of expense really is, and ought to be, in order to judge of the possible ameliorations of their management. On the Georgia Road, in 1840, the mere greasing of the engines amounted to more than 4 per cent. of the aggregate charges of the company. In 1842, this item was reduced down to less than 1½ per cent.

As another example of the effect of the same sort of economy in the detail—in small matters—may be adduced the curious fact, that the sum paid for oil by the Philadelphia and Baltimore Railroad Company, in 1841, amounted to $6,131, and 1842 it was reduced down to $2,151. In the year 1842 it amounted to 3⅓ cents per mile run, and in 1842 it scarcely exceeded 1⅓ cents per mile run by the trains.

The expense of oil is generally included under the head, "fuel, oil, salaries, general and incidental expenses, &c.;" "fuel, oil, salaries, wages, loading merchandize, and miscellaneous expenses;" "wages, fuel, oil, &c." This method of condensing accounts is so general, that out of the reports of more than thirty railroad companies for the year 1842, now on my table, I am able to select but the three following, from which the cost of the oil consumed by the engines, can be obtained separate from other items.

TABLE.

Name of Road.	Year.	Miles run by engines.	Cost of oil for engines.	Cost per mile run.	Remarks.
Georgia Road,	1842	153,873	$1,411	.9 cts.	Cotton waste is included in the charge on the Balt. & Ohio, and believed to be included in that of the Georgia ro'd.
Baltimore and Ohio,	1843	509,765	4,399	.9	
Philadelphia and Columbia,	1842	261,744	3,104	1.2	Including oil for stationary engine.

This table would seem to justify the assumption of 9 *mills per mile run*, for the consumption of oil and cotton waste by the engine and tender alone.

There is to be found a considerable list of reports in which the aggregate consumption of oil by *engines, tenders, and cars*, may be separated from all other items. I have also some manuscript statements from which these items can be obtained. The following table exhibits the aggregate cost of oil for various lines, and the cost reduced to the mile traveled by the train.

TABLE.

Name of Road.	Year.	Miles run by trains.	Cost of oil for engines and trains.	Cost per mile run.	Remarks.
Central Road,	1842	102,145	$ 1,103	1.0	Light trains.
Reading Road,	1841	83,717	1,621	1.9	Heavier trains.
Reading Road,	1842	198,055	3,936	2.0	Still larger average trains.
South Carolina Road,	1842	260,324	2,784	1.1	
Utica and Schenectady,	1841	155,828	3,500	2.2	Not strictly accurate.
Philada. and Baltimore,	1842	177,859	2,151	1.2	Chiefly passenger trains.
Georgia Road,	1842	153,873	1,821	1.2	Trains equal the preced'g.
Norwich and Worcester,	1842	144,321	1,947	1.4	Wei't of trains unknown.
Western Road,	1842	397,295	9,215	2.3	Heavy trains.
New York and Erie,	1842	24,564	481	2.0	Heavy freight trains.
Baltimore and Ohio,	1843	509,765	7,201	1.4	Lighter trains.

The consumption of oil and tallow may be estimated, in general, at 9 mills per mile run for the engine and tender, and an additional allowance of $\frac{1}{4}$ mill for each ton net conveyed one mile.

I have also the consumption of oil and tallow for some other roads, but as these statements manifest great and censurable extravagance, and cannot be used to show the necessary expenditure on a well conducted work, I have not included them in the preceding list.

Sawing Wood, Pumping Water, and Loading Tenders.—It is not easy to collect facts which will exhibit the actual cost of the items included under the present head for many roads; but it is very easy to estimate their average value by direct calculation. We know that it is worth, on the average, about 40 cents per cord to saw the wood suitably for this purpose: and we know also that a cord of wood is sufficient to supply the consumption of the engine while

running about 40 miles. It is, therefore, worth *one cent per mile run*, to cut the wood for this object. To load the tenders, where the business is regular and great, is worth about 20 cents per cord, or *a half cent per mile run.* The cost of raising the water depends more on the conveniences afforded by the situation. If we assume the average lift at 30 feet, the labor of a man will be equal to raising about 40,000 pounds per diem. Engines usually evaporate from 300 to 400 pounds of water per mile run, which brings the cost of pumping to about the $\frac{1}{110}$ of a day's labor—or about 8 mills *per mile run.* These items make together 2½ cents per mile run.

The result of experience for two roads is given in the following

TABLE.

Name of Road.	Year.	Miles run by engines.	Cost of sawing, loading, and pumping.	Cost per Mile.
Boston and Providence,	1842	120,000	$ 3,266	2.7
Philada. and Columbia,	1842	261,774	5,989	2.3
			Average,	2½ cts.

Locomotive Power.—We have now gone over the items in detail which compose the cost of locomotive power, and are, therefore, prepared to sum them up, and compare the aggregate of the averages with the amount at which it is stated in the formula, proposed for the computation of the aggregate annual expenses. These items are

	Cents.
Repairs of engines and tenders per mile run,	7.0
Fuel, per mile run,	9.0
Wages of train hands, per mile run,	8.0
Oil for engines and tenders, per mile run,	.9
Sawing wood, loading tenders, and pumping water, per mile run,	2.5
Cost of locomotive power per mile run,	27.4

It will, of course, be recollected that this result is independent of the injury to the road, which we have considered under the usual head of "extraordinary expenses."

The only division of these expenses which is liable to material variation, is the cost of fuel, the price of which varies with the localities. I have already offered an approximate correction of this item, which may be employed for general investigations; and shall shortly take occasion to present a more accurate formula for its computation, based upon a very extensive experience.

It might seem to the general reader, that after presenting the cost of repairs of the road, engines, and cars; the value of fuel and wages of train hands; the consumption of oil, and the injury to the iron, that there would remain but little more to adduce in the premises; but I have yet a very important division of the subject to discuss, which is much too frequently overlooked in investigations of this character.

There are other extraordinary expenses, and certain contingencies which go far to swell the annual charges on every line—without any exception in behalf of the most favorably situated, or of those which are most economically administered.

I proposed, in a former article, to offer an estimate of the probable expenses for the present year, on a railroad in active operation, which is now the object of much attention and interest, in order to exhibit an application of the formula in anticipation of the publication of the company's next report. I take the Philadelphia and Reading Railroad for this purpose; and assume that it will this year give transit to 250,000 tons of freight, and 40,000 passengers. The application of the formula to this work—making proper allowances for its gradients and drawbacks, the facilities for unloading, and having due respect to its age—will produce, for the aggregate expenses, the sum of $265,000.

This estimate, of course, refers only to the apparent expenses, and includes no part of those reserved charges—such as the wear of the iron—which are usually denominated "extraordinary expenses," because they are not generally of annual recurrence. The durability of iron rails I assume at about 800,000 tons—while they are estimated by the enthusiastic friends of the road, at 12,500,000 tons, and sometimes at infinity. Where such immense differences exist, time must decide the question. I trust that time may not show that I even am too sanguine, and expect more from the railroad system than it is capable of rendering.

(To be continued.)

Mr. Vignoles' Lectures on Civil Engineering, at the London University College.

(Continued from vol. vi, p. 394.)

Second Course—Lecture xvii.

Before proceeding to a summary of the second course, Mr. Vignoles observed that there was a material point connected with the subject which had not been sufficiently discussed, viz., the motive power to be employed; on this greatly depended the principles on which a line of railway should be laid out, the end and object being to convey the greatest extent of traffic at the least cost: this cost was compounded, first, of the interest of the capital expended, which should be considered a constant charge; and second, of the periodical working expenses—the work to be done being summed up in the general expression of "overcoming all obstacles to facility of motion." What are these obstacles? They might be divided into two great heads—Gravity and Friction. 1st. Gravity is a natural cause existing under all circumstances, and, affecting lines deviating from the horizontal, in direct proportion to the sine of the angle of inclination. Engineers, therefore, have considered that the first principle of laying out roads, should be (under limits) to approximate as nearly as possible to the horizontal, in order to exclude one of the great causes of obstacle; since, with maximum loads, the retardation arising from gravity is most felt. When such could not be effected, then to dis-

tribute the total rise (or effect of gravity) along the easiest ratio of slope. But, in practice, the occurrence of maximum loads, in ordinary passengers and merchandize traffic, forms the exception, instead of constituting the rule, and it is only when a regular and constant heavy trade is to be anticipated, that horizontal communications should be insisted on. 2nd. Friction, is a physical cause, varying according to the perfection of the road, and of the vehicles moving on it. In the practical working of a railway, however, so many expenses arise under the heads of "conducting traffic, management, &c.," common to most lines, whatever the gradient, that they tend to make the cost of overcoming friction, and even gravity, (particularly with the ordinary light loads) but a small fraction of the total charges. Comparing the amount of obstacles on a railway with that on the ordinary road (where the friction, meaning thereby axletree friction, and surface resistance, may be called sixteen to twenty times greater than on a railway,) and assuming the inclination on railway and road to be the same, the general result is that the perfection of the railway surface moved over, and the improvement of carriages, or rather that of their wheels and axles, cause the effect of gravity to be felt in the most sensible degree on railways; while the imperfection of the road causes it to be comparatively scarcely appreciated. Hence with the wretched surfaces of the old roads, and the clumsy wheels of our primitive vehicles, the hills seem to have scarcely added to the obstacles to be overcome. As the road surfaces and carriages improved, and increased speed, and heavier loads were introduced, the necessity for the greater perfection of the ordinary road became apparent, and the remedy was applied in various degrees during the last 100 years until it was completed as far as possible, in the extensive improvements by Telford and Macneill on our great highways. But in carrying out this principle on railways we have run into the opposite extreme. We should first take in one sum the retarding causes of gravity and friction, viz., the friction, being constant, or nearly so, putting aside the resistance of the air, at high velocities, vary only in the perfection of the wheel axles, and in the mode of lubricating, (the surface resistance on railways being, practically speaking, nothing,) and the maximum gradient, or rather the gravity due to it: their sum will be the constant divisor for the motive power, of whatever description that motive power might be; and, in considering the latter point, it must be the distribution of the traffic, or what may be called the average hourly load throughout the year, which is to determine the question. In many instances, in this point of view, it would probably often be found most economical to use animal power, (as is done on the Edinburgh and Dalkeith Railway,) were not velocity required—which, on railways, enters so materially into the calculation, that mechanical power in some shape becomes necessary; and this divides itself into stationary power, or when the mechanical means are fixed, and locomotive power, or when the machine travels along with the load. There are two serious difficulties connected with the latter system; first, a great addition to the load, equivalent, on the average, to doubling it; and next, that the fulcrum through

which the motive power must be transmitted—that is, the rail on which the locomotive driving wheel impinges—is greatly affected by atmospheric causes, occasioning great variation in the adhesion, and consequent uncertainty from slipping of the wheels, so that, as explained in a former lecture, the load after a locomotive engine is really limited by its adhesive power, and not, as might at first be supposed, either by the cylinder power, or boiler power. Considered abstractedly, stationary power is cheaper, and always would be so if the traffic were certain and regular, with maximum loads and very moderate speed, even with the present obstacles of ropes, sheaves, and all their contingent complicated apparatus; but at high speed, with a great length of rope, the experience of the working of the Blackwall Railway has shown that for passenger trains only, there was, compared with the most expensively worked lines on the locomotive system, to say the least, no economy in the motive power, though other conveniences arising from the peculiar arrangements on that line, were, perhaps, in this special case, more than an equivalent. A most serious obstacle to stationary power, was the necessity of absolutely stopping, and disengaging and refixing the trains at each station, which stations could not be conveniently, and certainly not economically, placed further apart than three, or five miles, for it could readily be proved, than on a continued distance of six or seven miles of railway worked by a rope, the power of the largest engine that could well be erected, would be absorbed in moving the rope only. The Professor then went largely into a consideration of applying stationary engines as the motive power in working inclined planes under a variety of circumstances, and recommended to the students to consult the valuable work of Mr. Nicholas Wood on this subject, and indeed on all the details of railway working, of which, particularly in the third edition, there was most of the latest information. In many situations, however, where water power could be obtained, the stationary rope and pulley system might be advantageously introduced. Gravity became the motive power, on what where called self-acting inclined planes; that is, when the gravity of a descending train of laden carriages brought up a train of others empty, or partially laden; or where skeleton wagons, or water tanks on wheels, could be used as artificial counterbalancing weights in either direction alternately; the circumstances under which self-acting inclined planes could be properly introduced were rare. Mr. Vignoles then gave a clear account of various modes of working self-acting inclined planes; among these was described a curious and interesting one near the great limestone quarries in North Staffordshire; another on the St. Helen's and Runcorn Gap Railway, which he had himself put up, and also the planes for the Great Portage Railway, across the Allegheny Mountains, in the United States of America. Stationary power might also be used to a greater extent on the atmospheric system, whereby, to speak metaphorically, a rope of air was substituted for a rope of hemp, or wire, and where no pullies were required, nor any necessary stoppage at the intermediate engines, where only the carriages had to be moved, and where nearly the whole dynamic force generated was

made available for motive power. This system had already been explained to the class, and practically illustrated on a railway thus worked, and need not be further alluded to. The Professor was preparing for publication a separate lecture "On the Atmospheric Railway System," to be illustrated with plates, and tables, and appendices, in which that interesting subject would be fully gone into, and all the mathematical and philosophical investigations given, with estimates of the cost of such railways under various circumstances of traffic and gradient; fully enabling the value of the principle, as a motive power, to be appreciated. Although modern practice had almost discarded the use of animal power from railways, it might be proper to refer cursorily to it. A horse seems adapted to drag vehicles, from the mode in which he adjusts his muscular action, so as to throw the greatest effect on the line of draft; in making an effort to draw a carriage, the body of the animal is bent forward, throwing upon the latter the part of its weight necessary to overcome the resistance, the muscular force of the legs being employed in keeping up his traction, and moving the body onward; the effort of the animal being resolvable into these two parts, viz., the action on the load, and that required to move itself by. It may be gathered from writers on this subject, that the force a horse is capable of exerting, is that equal to about one-seventh, or one-eighth part of his own weight: or that, on an ascent of one in seven, or one in eight, the exertion required to overcome his own gravity, is a force equal to that he is able to exert on a load on a level plane. Taking the average weight of a horse, and considering that he is capable of occasionally exerting great extra power on the load, still it seems to be satisfactorily ascertained, that nearly seven parts out of eight of the muscular power of a horse is required to drag his own weight forward, leaving, of course, only one part applicable to the load. But the criterion of a horse's power, in practice, is not the occasional effort of which the animal is capable at a dead pull, or for a short period: we must estimate his strength by what he can do daily, and day after day for a long period, and without breaking him down prematurely. If a horse is to travel at the rate of 10 miles an hour, his power of pulling is greatly diminished, and he can work only an hour or so in the day: at two miles an hour he may give out a power of 150 lbs. on the load: at 10 miles he has scarcely 35 lbs. to spare, and at 12 miles an hour, he can seldom be expected to do more than move himself. This was on the average of horses—all beyond were exceptions. Thus, the application of horses to railways, as the motive power, was very limited; and in laying out lines where they are to be used, to full effect, gravity should be arranged to be always with the load, or, at least, not against it; the rate of traveling only 2 or 2½ miles per hour, and the traffic uniform. Mr. Vignoles proceeded to an interesting comparison between locomotive and stationary power up inclined planes, taking the inclination of 1 in 50 as a maximum, and showed that *when the traffic was small, and the loads consequently comparatively light, and the daily number of trains not great, locomotive engines*, as the motive power, (taking into consideration all circumstances of first cost, and working

expenses, particularly the latter, of which the locomotive power was but a small part,) *would not be so expensive as stationary engines*, while they would be certainly more convenient; and that, with all the best modern improvements in the locomotive engines, the system of working with large cylinders, using the steam expansively on the level, and falling parts of the railway, improved boilers, &c., *planes of* 1 *in* 50 *might be practically worked:* the only material drawback being occasional slipping of the wheels on the ascent, and the necessity of great caution and careful application of the brakes on descents; but on the whole, the balance, *under the above circumstances*, was much in favor of the locomotive system. The Professor then entered into a very long and minute comparison of the present system of working the Blackwall Railway by stationary engines, with ropes and pullies, with what would be the case if the motive power were locomotive engines—and by tables, showed that while the working of the Blackwall Railway (3½ miles) on the stationary system, was costing about *seventy-two pence* per mile per train, the cost of working the Greenwich Railway (3¾ miles) was only about *forty pence:* but Mr. Vignoles admitted, that by the former, great accommodation to the public was afforded by the numerous intermediate stations, while on the latter there was only one stoppage. In concluding the general comparison between the two principles of mechanical motive power, the Professor observed, that on the locomotive system, a minimum of power need only be provided in the first instance, and the number of engines might be increased gradually as the traffic required, which was a great consideration when the first expenditure of capital had to be kept down to the very lowest terms, at all future risks. On the stationary system, provision had to be made, from the outset, for the maximum anticipated trade, which, of course, increased the first outlay on the railway establishment, and depended on the ultimate economy of future working to make up the difference. Having concluded the notice of various descriptions of *motive power* employed on railways, of which the preceding is but a mere outline, some general remarks were made on the principles of laying out railways, in reference to the several systems respectively.

In a concluding general summary, Mr. Vignoles observed, that in his first course, at the latter end of 1841, he had fully considered the practical rules for earthwork and constructions:—these were not peculiar to railways; the theory and practice of bridge building, applied to all internal communication, and would be most conveniently considered in a separate illustrated course, but he wished to recall to the class generally, that in proceeding to lay out railways, in the first instance, the engineer ought to enter much more deliberately into those previous inquiries, so absolutely necessary, than had hitherto been done. A system of applying the same general rule of perfect gradients alike to lines, of the least as well as the greatest traffic, had too much prevailed, and until more rational ideas were substituted, the public would shrink from embarking in enterprizes subject to all the contingencies of extra cost beyond estimates, which had characterized almost every railway in this country. *The earthwork and its*

consequences, regulated the cost, particularly as regarded contingencies, and the utmost consideration should be bestowed as to how far it was justifiable to encounter the expense of these operations. The average cost of earthwork, and all consequent works of art, &c., on the English railways was nearly £15,000 per mile, or about 50 per cent. of the whole capital expenditure. Mr. Vignoles was decidedly of opinion that in *all future lines in this country, and particularly on the continent*, the corresponding outlay *ought not to exceed* £5000 *per mile*, and that beyond that sum perfection of gradient would be bought too dearly. In reference to the *gauge* of railways, Mr. Vignoles stated, distinctly, that theoretical investigations, and practical results, led him to consider a six foot gauge the best; but the present 4½ foot gauge was certainly rather cheaper. In respect of *curves*, he observed, that they were much less disadvantageous than had been first supposed: that a half mile radius was now everywhere admitted; and that he himself did not hesitate to adopt a quarter mile radius whenever expense could be materially saved; and if the atmospheric system of motive power should be found to succeed on a large scale, the curves might, on lines thus worked, be safely made still sharper. In regard to the systems of constructing the *upper works*, he had, in a recent lecture, entered so fully into the comparison, that he need only now say, that if the expensive and complicated system of heavy rails and chairs, and cross sleepers, were preferred by engineers, then the ingenious improvements of Mr. May, of Ipswich, in chairs and fastenings, applied by Mr. Cubitt on the South Eastern (Dover) Railway, with great care in laying, draining, and ballasting, made *that system* perfect and complete. The Professor, however, decidedly gave the preference to the less costly, and the more simple system of lighter rails, without chairs, laid on continuous longitudinal balks of timber of sufficient scantling, and fastened on Evans' principle, modified in the manner shown by the models exhibited to the class; and several engineers were adopting this opinion. On the continent of Europe, where iron was dear, and timber cheap and abundant, Mr. Vignoles calculated *a saving of full* £2000 *per mile of double road would accrue from the adoption of the latter system*—which offered a vast national economy. In reference to the subject of working drawings, plans, and sections, the Professor reminded the class of the importance he attached to having all such previously made out on a large scale, that the cubic quantities might be accurately obtained, and the just prices considered; and thus, in proceeding to make the estimates, nothing would be left to conjecture, and as little as possible left to be afterwards altered. The period of time for the execution of the works should be extended as far as consistently could be done. The two great sources of the extra expenditure on railways had been, the extreme haste with which the works had been pushed on, and the changes of every kind from the original designs. These points being all carefully considered, *even before the plan was brought before the public in general*, the estimates might be better depended on. Mr. Vignoles then went through all the great items of expendi-

ture generally arising on first construction, and explained how the accounts of measurements should be made out, and kept under very distinct general heads, subdivided into minor items, from the purchase of the land to the last finish to the stations, and the entire fitting up and furnishing of the carrying establishments. Sufficient experience had been attained in all these matters to enable the engineer, in future, if the above rules were faithfully followed out, to place himself beyond all chance of reproach for making erroneous estimates. In conclusion, the Professor observed, that he had selected *railways* at the request of the class, as the theme for the course just concluded; but although so much consideration had been given to the subject, he had only been able to touch in a very general way upon the chief points; yet it was to be hoped a sufficient idea had been given of the principles of construction, and of their general application, to create an interest in their minds. Should any of the students hereafter be employed to execute a railway, he trusted they would recollect these lectures with advantage, while they would also probably better understand and appreciate them; at the same time, he must not neglect to impress upon them, that it was not at the college, in the lecture room, or even in the office of an engineer, that all the duties and knowledge necessary could be taught; the young aspirant must pass much time in the workshop; indeed, he must become a workman, and acquire the use and skill in the handling of tools, and the erection of mechanism of every kind—and passing to the actual works, ought to learn to be able to direct personally the labor of the mason, the carpenter, and the smith. "Above all," said Mr. Vignoles, "the student in engineering must carry into life with him the constant remembrance of what I have so repeatedly enforced, that the reputation of an engineer in this country is based upon the success of his works, of his mechanism, and of all the efforts of his mind and hand, in respect to, and in proportion to their being productive of commercial and beneficial results, to those who, at his suggestion, may undertake to provide the necessary funds; and he should consider how this result can be best obtained, rather than study the splendor of his undertakings. It is for the architect to attend to the decorative and the beautiful; it is sufficient for the engineer to study proportions, and rely on the simple grandeur of his works as a whole. It is related that Napoleon once observed to the celebrated Carnot, "*Lés ingenieurs doivent toujours avoir des idées magnifiques;*" this is true as to their first conceptions, but in the realization, they must be sobered down by the rules of economy and judgment. After the first burst of talent, after image and form has been given by the hand to the bright idea emanating from the brain, let it be brought down to practical application only after a strict inquiry into the cost. Remember what I quoted on a former occasion, when contrasting the two celebaated light-houses, the *Eddystone*, and the *Cordoun*—no unfit emblem of the two celebrated engineers who erected them, may I venture to add, of their respective nations—remember, I say, "*'tis use alone that sanctifies expense.*"

***Results of the application of Horse-power to raising Water from the working shafts of Saltwood Tunnel, on the South-eastern Railway, in* 1842.** By FREDERICK WILLIAM SIMMS, Esq., M. Inst. Civil Eng.

This tunnel is driven in the middle bed of the lower green sand, between which and the surface of the ground is interposed only the upper bed of the same stratum; but in sinking the eleven shafts for the work, it was found that at the level of the top of the tunnel, the ground assumed the character of a quicksand, saturated with water, in such quantity that it could not be reduced by manual labor. Under these circumstances horse gins were erected for drawing the water by barrels, containing one hundred gallons each, weighing when full about 1310 lbs.

The engineer's intention was to drive simultaneously from these shafts, in the direction of the tunnel, an adit, or heading, to carry off the water; but the earth, which was sand mixed with fine particles of blue clay, was so filled with water as to become a mass of semi-fluid mud, great exertions were, therefore, necessary to overcome the water without erecting pumps. At first this was accomplished by making each horse work for 12 hours, and then for 8 hours per day, allowing one hour for food and rest; as the water increased it became necessary to work night and day, and the time of each horse's working was reduced generally to 6 hours, and sometimes to 3 hours. As all the horses were hired at the rate of seven shillings per day, the author, who had the direction of the works, ordered a daily register to be kept of the actual work done by each horse, for the double purpose of ascertaining whether they all performed their duty, and also hoping to collect a body of facts relative to horse-power which might be useful hereafter. This detailed register, which was kept by Mr. P. N. Brockedon, is appended to the communication.

The author gives as a proposition, "that the proper estimate of horse-power, would be that which measures the weight that a horse would draw up out of a well; the animal acting by a horizontal line of attraction turned into the vertical direction by a simple pulley, whose friction should be reduced as much as possible." He states that the manner in which the work was performed necessarily approached very nearly to these conditions; and after giving the principal dimensions of the horse gins, he analyzes each set of experiments, and, by taking the mean of those against which no objections could be urged, he arrives at the following results:

The power of a horse working for	8 hours	= 23,412 lbs.	raised 1 foot high pr. min.	
Do.	do.	6 "	= 24,360 "	do.
Do.	do.	4½ "	= 27,056 "	do.
Do.	do.	3 "	= 32,943 "	do.

Of these results he thinks the experiments for 6 hours, and for 3 hours, alone, should be adopted as practical guides, all the others being in some degree objectionable.

As a means of comparison, the following table of estimates of horse-power is given:—

Name.	Pounds raised 1 foot high in a minute.	Hours of work.	Authority.
Boulton and Watt,	33,000	8	Robison's Mech. Phil., vol. ii. p. 145.
Tredgold,	27,500	8	Tredgold on Railroads, p. 69.
Desagulier,	44,000	8	Dr. Gregory's Mathematics for Practical Men. p. 183.
Ditto,	27,500	Not stated.	
Sauveur,	34,020	8	
Moore, for Society of Arts,	21,120	Not stated.	
Smeaton,	22,000	Not stated.	

These are much higher results than the average of his experiments, and would more nearly accord with the extremes obtained by him; but under such excessive fatigue the horses were speedily exhausted, and died rapidly. Nearly one hundred horses were employed, they were of good quality, their average height was 15 hands ¼ inch, and their weight about 10½ cwt., and they cost from 20*l.* to 40*l.* each. They had as much corn as they could eat, and were well attended to.

The total quantity of work done by the horses, and its costs, was as under:

		Tons.
Registered quantity of water drawn 104 ft., the average height, 28,220,800 gallons,	=	128,505
Registered quantity of earth 3,500 yards, 1 ton 6 cwt. per yard,	=	4,550
Total weight drawn to the surface		133,055

	£	*s.*	*d.*
Total cost of horse labor, including a boy to drive each horse,	1,585	15	3

Or, 2.85 pence per ton, the average height of 104 feet.

Lond. Mech. Mag.

Franklin Institute.

SUPPLEMENTARY REPORT

Of the Committee on the Thirteenth Exhibition of American Manufactures, held in Philadelphia from the 17th to the 28th of October, 1843, by the Franklin Institute of the State of Pennsylvania, for the Promotion of the Mechanic Arts.

The following awards are made made in conformity with the revised reports of the judges, on the several articles named:

II.—*Woolen Goods.*

Nos. 145 to 147, embossed table covers, by Duncan & Cunningham,

Belleville, N. J., deposited by D. S. Brown & Co., considered by the judges to reflect great credit on the manufacturers—a silver medal.

No. 148, embroidered woolen Thibet shawls, exhibiting great improvement in this article, made by Duncan & Cunningham, Belleville, N. J., and deposited by D. S. Brown & Co.—a silver medal.

IX.—*Saddlery, Harness, and Trunks.*

No. 358, harness, by William N. Lacey, recommended by the judges in a supplementary report for the award of a medal—a silver medal.

XIII.—*Musical Instruments.*

No. 1201, by Henry Corrie, deposited by James Cox, an organ, in regard to which the judges say that "the arrangement of the stops and pedals, is, in some respects, novel and allows of every possible variety of combination, and the stop denominated the Euphonia, may yet be regarded as new"—a certificate of honorable mention.

XXIV.—*Leather and Morocco.*

No. 390, by Taylor & Kinsey, of Philadelphia, Tampico French leather, recommended for the award in the supplementary report of the judges—a silver medal.

No. 399, by Scattergood & Bousted, Russet bridle leather, recommended for the award in a supplementary report of the judges—a silver medal.

No. 318, by Charles B. Williams, slaughter sole leather, recommended for the award in a supplementary report of the judges—a silver medal.

XXVI —*Chemicals.*

No. 320, by Mrs. Mary West, for the excellence of the jeweler's rouge, prepared by her—a certificate of honorable mention.

XXXIII.—*Paints and Colors.*

No. 309, by Wetherill & Brothers, the smaller sample of white lead, which may, in the opinion of the judges, supersede the Kremnitz white—a certificate of honorable mention.

Extracts from the Reports of the Judges appointed to examine the Articles offered at the Thirteenth Exhibition of American Manufactures.

Report on Cotton Goods.

The Committee on Cotton Goods have carefully examined the several articles submitted to their inspection by the Franklin Institute, and respectfully report as follows:

No. 2, fine bleached longcloth, manufactured by Benjamin Marshall, New York Mills, Whitestown, N. Y., is a very superior article, stout, fine, even, and compact, and is believed to be the best ever made in the United States, rivaling the famed British longcloth—it merits special notice. A sample of the unbleached cloth is also exhibited, differing from the above only in color.

No. 49, Preston longcloth, manufactured by the Lonsdale Company, Providence, R. I., an excellent, well made shirting, which would be more highly esteemed in the absence of the above, which casts a shade over all others. There are also good samples of bleached shirtings and sheetings from the Bartlett, Phœnix, and Steam Cotton Manufacturing Companies, and brown sheetings from the Stoneville Manufacturing Company.

No. 20 Earlston ginghams, manufactured by R. Beath, a fair article, the finish improved upon former specimens.

No. 40, ginghams, manufactured by Hood Simpson, Philadelphia, a fair imitation of the imported Manchester ginghams.

No. 47, imitation linen diaper, manufactured by John Elliott, Philadelphia, a well made article fairly representing what the title purports.

Bleached Canton flannel, manufactured by S. Sheppard & Sons, well made, strong, substantial, and smooth, and altogether a serviceable article. A good specimen of similar goods is also exhibited from the Amoskeag Manufacturing Company.

Tickings, of fair quality, from the factories of James Campbell, and Robert Whitaker.

Tapes, cotton cords, and laces, manufactured by Thomas Brown, Blockley; Fletcher & Bros, Providence, R. I.; I. Learch, Philadelphia; and Ezra I. Cady, Centreville, R. I., are creditable specimens. The striped tapes, by Thomas Brown, are noticed as a new article, and very good.

Turkey red cotton yarn, from James Wright, was referred to the Committee on Exhibitions, subject to their decision upon the expediency of submitting it to chemical tests.*

The display of Printed Cottons is unusually large, and brilliantly illustrates the great perfection attained in this branch of manufactures.

The American, and Hamilton Print Works, and Joseph Ripka, exhibit favorable specimens of their skill, but those presented by J. Dunnell & Co., Pawtucket, R. I., A. Robeson, Fall River, Benj. Cozzens, Providence, R. I., and Perkins & Wendall, Bustleton, Pennsylvania, are of surpassing beauty, combining elegance of design, brilliancy of coloring, and accuracy of execution in an extraordinary degree. Of these competitors we are unable to select one as pre-eminently meritorious, where all are so highly commendable.

Printed furniture chintzes from A. Robeson, Benj. Marshall, and American Print Works, and window shades from Hamilton Print Works, are in good taste and well executed.

Very handsome and chaste styles of printed lawns are exhibited from A. Robeson, Fall River.

Perkins & Wendall have produced a variety of beautiful styles in lawns, balzorines, and mousselines de laine, evincing taste and skill of no common order, well deserving a premium.

This is a new branch of printing here, in which success is no longer doubtful. Your committee are informed that extensive preparations

* Those appropriate tests were applied by Professor Booth, and Mr. Boyé, and on their report a certificate of honorary mention was awarded.

are making in a factory for spinning very fine yarns, and weaving the lighter lawns and muslins. All who have viewed the rich array of Printed Goods must be impressed with the extraordinary advancement in this department.

With the exception of Printed Goods, the specimens are not so numerous as upon some former occasions; this may arise from the fact of many of the staples having attained so great perfection, that there is scarcely room for improvement. This exhibition, as well as former ones, has also been deprived of some samples of new fabrics, owing to the reasonable unwillingness, on the part of manufacturers, to expose to view samples of new goods in advance of the selling season.

The Cotton manufactures of the United States are constantly growing in importance; beside supplying the largest portion of clothing required for home consumption, large quantities are annually shipped to foreign countries: they are in demand in Mexico, South America, California, &c., and recently a market has been opened for them in China. If the Institute has, in any degree, by encouragement, assisted in advancing this branch of manufactures, there is reason to rejoice, and to continue efforts in its favor.

Report on Iron and Steel.

The Committee of Judges of the Iron and Steel exhibited at the Exhibition of American Manufactures, now held in the Philadelphia Museum, by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, respectfully report:

That the samples submitted to their inspection were generally highly creditable to the manufacturers, and afford gratifying proofs of the progress made in the manufacture of Iron and Steel, those essential articles upon which depend almost all other manufactures.

A certificate of honorary mention is recommended to be given to Morris & Jones, for the very handsome display of iron and steel contributed by them, from the iron ore to the finished bar.

The specimens of rolled iron, both flat and round, from the Colemanville Iron Works were of excellent quality.

Some of the hammered iron from William Dowlin, of Mary Ann Forge, Chester county, was very superior.

Very good samples of iron from the Tredegar Iron Works, at Richmond, Virginia, deposited by James S. Spencer, jr., came too late for competition.

Bundles of nail rods from the Colemanville Works, deposited by Morris & Jones; from Valentine & Thomas, deposited by Isaac Miller; and from the Howard Iron Works, deposited by E. J. Etting & Brother, were all excellent, and so nearly alike in quality as to make it difficult to discriminate between them.

Specimens of imitation Russia sheet-iron, by James Wood & Sons, for which a silver medal was deservedly awarded last year, are fully equal to those then exhibited.

Samples of sheet-iron, deposited by T. S. Speakman, and intended to imitate the Russian, were examined by the committee, but Mr. Speakman has not yet succeeded in giving the peculiar glaze characteristic of the article.

Some common sheet-iron from Colemanville, is very well rolled, and has a smooth surface.

A certificate of honorary mention is recommended to be given to J. L. Mott, of New York, for a cast-iron bathing tub in one piece, being of good form and size, and weighing only 268 lbs. This is a new article to the committee, and they think it might be made still lighter by a proper mixture of pig iron, with the use of a portion of anthracite iron, which has been so successfully used for hollow ware.

The specimens of hollow ware and other castings, by Savery & Co., of Philadelphia, are so admirable, that the judges recommend the award of a silver medal to those gentlemen for the excellence of their articles, unless they have received one from the Institute at some former exhibition.

The steel converted at Colemanville Iron Works, deposited by Morris & Jones, is a pretty fair sample of American blistered steel, and the spring steel from the same place, has a good appearance, and is very well rolled.

Blistered steel by Broadmeadow, from Balliott's iron, is tolerably good.

Samples of steel, said to be cast-steel, from Broadmeadow & Stanton, of Manayunk, are better than the blistered steel, but not equal to good English cast-steel.

The blistered steel converted by John Robbins, jr., of Kensington, from Swedes' iron, is a very superior article. That by him from American iron, intended for saw-plates, appears to be good, but the committee have not had time to test it. For the general excellence of Mr. Robbins' steel, the committee recommend him a certificate of honorary mention.

A sheet of boiler iron 11 feet 4 inches by 26 inches, by S. Hatfield, deposited by William F. Potts, is very smoothly rolled, as is also a large sheet deposited by Morris & Jones.

Report on Umbrellas.

The Committee appointed to examine the Umbrellas in your present exhibition, beg to report that they have carefully examined them, and find—

No. 42, to be a case of highly finished handles and knobs, tastefully designed, and well executed.

Nos. 203, 247, and 268, are an excellent assortment of well finished umbrellas, parasols, and sun shades, and are a great credit to the manufactories of this city.

Your committee have peculiar pleasure in recommending these to notice, because they have reason to know that they were not prepared for exhibition, and they are not, therefore, proofs of how high a state of perfection these could be carried; but they are proofs of the

excellence of the stocks from whence they were selected. Your committee would more particularly recommend to notice the parasols and sun shades manufactured by Messrs. W. & W. H. Richardson, of an entirely new fashion, and also those manufactured by Mr. W. A. Drown, all of which are proofs of beautiful workmanship.

Your committee would be pleased if they were at liberty to refer to two cards of sun shades, manufactured by Messrs. Sleeper & Brothers, of American silk only. When this article shall be fully introduced, we anticipate for it a large demand for this purpose.

Report on Lamps and Gas Fixtures.

The Committee on Lamps and Gas Fixtures report, that the display in this department, although not so extensive as on some former occasions, is certainly unsurpassed in point of beauty and excellence of the specimens. Messrs. Cornelius & Co., to whose enterprize is due the greater part of the magnificent display of Lamps and Gas Fittings, seem to have made a successful effort to combine increased perfection of shape and finish with a very considerable reduction of cost to the purchaser. We would notice particularly the richly ornamented gas pendants and chandeliers finished in Ormoulu, the workmanship of which is exceedingly beautiful, the color faultless, and the whole effect such as may satisfy the most fastidious taste. The silver chandelier and candelabra are remarkably chaste, and, in combination with the judicious arrangement of the glass ornaments, produce a very brilliant effect. The silver coating on these articles is produced by the speedy operation of the galvanotype, and appears to be more perfect than is generally produced by that recent art. The humbler solar and lard lamps deserve more than the passing notice which they receive at the hands of the committee, and will, no doubt, serve to gratify the good taste, and aid the vision of a far greater number of our fellow citizens, than will the more showy and expensive chandeliers. For their rich display, the committee cannot hesitate to recommend the award of a silver medal to Messrs. Cornelius & Co.

They would also recommend the award of honorable mention to E. Whelan, for No. 728, a pair of silvered candelabra, which are deemed creditable to his skill. To J. S. Gold, for an assortment of camphine lamps and chandeliers, got up with judgment and good taste. To Ellis S. Archer, for a variety of lard lamps. To Filley & Kisterbock, for a display of similar useful articles.

Report on Models and Machinery.

Whilst the judges have occasion to regret, that the display of Models and Machinery falls short of former exhibitions, they can, nevertheless, trace amongst the one hundred and fifty specimens, which are now deposited, abundant evidence that the hand of the American mechanic has not lost its art, and that it needs but suitable occasions

to call forth a superior degree of genius in design, and skill in execution.

No. 1538, a two oared skiff, built by James & Joseph Albertson, Beach street, Kensington, with an oak frame, cedar planking, copper fastened throughout, and having the rowlocks faced with brass; is an elegant piece of workmanship, and deserves the first place in this department. For this we recommend the award of a silver medal.

No. 1631, copying presses, of excellent workmanship, by Charles Evans, of Philadelphia, deserves a silver medal.

No. 1503, a horizontal steam engine, built by James Brooks, of Frankford, acting as the motor of the working models in the lower saloon, appears to be a good and serviceable piece of work, and deserves a certificate of honorable mention.

No. 1504, a locomotive boiler, built by J. W. & J. F. Starr, of Kensington, which is now employed to supply steam to the preceding engine, is an excellent specimen of work, and fully sustains the high reputation of that well known firm; it deserves a certificate of honorable mention.

No. 1516, a slide rest, by William Bien, of Philadelphia, is well made, and deserves a certificate of honorable mention.

No. 1530, a box of shuttles, by E. S. & R. O. Tripp, of Trenton, N. J., are very well made, and deserve a certificate of honorable mention.

No. 1531, four platform scales, made by J. D. Dale, of Lansingburg, N. Y., appear to be of a very serviceable character, and deserve a certificate of honorable mention.

No. 1570, an ice apparatus, which, by distributing water upon a plane surface in thin jets, appears to be well calculated to make ice of a considerable thickness, at temperatures but little below the freezing point; it deserves a certificate of honorable mention.

No. 1577, a log brace for saw-mills, by Mr. Cushwa, of Washington county, Md., is designed to support the middle of a log near the saw, by means of a roller and lever; this seems to be a useful contrivance; it supplies a want often felt in cutting long timber, and deserves a certificate of honorable mention.

No. 1582, an apparatus for corking bottles of mineral water, is a machine ingeniously devised, by D. C. Palmer, to cork up gaseous waters without loss of gas; and it deserves a certificate of honorable mention, both for its design and workmanship.

No. 1583, a sub-soil plough, by D. O. Prouty, dealer in agricultural implements, is a good specimen of this new tool, which is producing such admirable effects in England, when properly applied to the tillage of soils; and we think it deserving of a certificate of honorable mention.

No. 1596, an abridged set of stencil plates, by George W. Duncan, of Philadelphia, in which, by a judicious arrangement of straight and curved slits, representing the elementary lines which form letters, and numbers, the whole alphabet, and all the digits are produced with facility; this deserves a certificate of honorable mention.

No. 1598, a small lathe, by William M. Davis, machinist, Philadelphia, of which the work is of a fair character, and deserves a certificate of honorable mention.

No. 1617, fire proof chest, water coolers and filters, by David Evans, of Philadelphia, the fire proof having an escutcheon that masks the keyhole in a manner so ingenious and effectual, as to make it very difficult for any one not possessed of the secret, to effect an entrance. All the articles exhibited by Mr. Evans, are creditably made, and deserve a certificate of honorable mention.

No. 1618, hatters' heating irons, by John McCoun, are good specimens of work, and deserve a certificate of honorable mention.

No. 1619, three bricks, made by George Snyder, are very smooth, well shaped, and dense; they seem to be machine made, and deserve a certificate of honorable mention.

No. 1634, several shuttles, for looms, by Ellis Jackson, of Philadelphia, are very well made, and deserve a certificate of honorable mention.

No. 1640, a power loom shuttle, by Jacob Senneff, is a neat piece of workmanship, and deserves a certificate of honorable mention.

No. 1654, a blacksmith's bellows, by S. W. Metz, of Philadelphia, is very well made; it has a new mode of inserting the tuyere pipe, which appears to be a real improvement, and deserves a certificate of honorable mention.

No. 1661, Laubauch's patent blacksmith's tuyere, deposited by John Murphy, of Philadelphia, furnishes an efficient blast from the bottom of the fire; it has been very favorably reported upon by the Committee on Science and the Arts, and well deserve a certificate of honorable mention.

No. 1665, a model of a hipped roof slated, by Wm. Elliott, blue slater, of Francisville, in which plane, diamond, spade, and scale slating, are very neatly executed upon the four pitches of the model roof; these several varieties, with sufficient fineness of finish, give indications of being perfectly weather proof, and well deserve a certificate of honorable mention.

No. 1689, a small steam engine, by Greer, Amer & Newell, of Philadelphia, made upon the plan long since used by Mr. Greer, of causing the supply pump to form the piston guide, is a very good and substantial piece of work, which has all the requisites of a serviceable engine, without any extraneous display. This machine well deserves a certificate of honorable mention, if not a silver medal.

No. 1702, a machine for cutting tenons, by Mahlon Gregg, of Philadelphia, is well made, appears to be efficient, and deserves a certificate of honorable mention.

No. 1715, a slide lathe rest, by J. H. Schrader, Philada., is made with very great nicety; it possesses all the requisites of this important appendage to the lathe, and, in addition, has regulating screws to give it the proper direction in conical and angular tenoning. This well deserves a certificate of honorable mention.

A number of models of locomotive and other steam engines, were before us, in which we could trace such disproportion amongst the

parts, and such defects in plan, that if it were not for the fact, that their errors are generally so glaring, we could wish them dismissed from the exhibition, but which, as it is, will but form exemplars, *not to be imitated* by the young mechanic.

Stillman & Co., of the Novelty Works, New York, exhibit a small horizontal steam engine, of which the workmanship is fair, and some of the parts of which are very well arranged, but came too late for competition.

Landreth & Munns, D. O. Prouty, and Edwin Chandler, dealers in agricultural implements, deposit a number of tools of value to the farmer, amongst which we notice some excellent corn shellers, straw cutters, ploughs, and winnowing machines, all apparently well made, and efficient implements of tillage.

James Young, of the patent agency, No. 50 Commerce street, Philadelphia, exhibits a number of ingenious machines of considerable value in various branches of industry.

To Landreth & Munns, D. O. Prouty, Edwin Chandler, and James Young, we recommend the award of certificates of honorable mention, for the number and general ingenuity of the machines exhibited by them.

Oliver Evans, of Philadelphia, exhibits a self-adjusting counter spring, which deserves to be brought before the Committee of Science and the Arts; he also exhibits a capital rectangular provision chest and water filter, with an ice apartment, which, after a whole summer's use, appears to be as good as if new.

B. G. Wilder, of Mamaroneck, N. Y., exhibits several of those celebrated salamander book safes, which stood so well an actual test by fire in the city of New York some time ago; they seem to deserve their reputation, and we regret that they came too late for competition.

W. H. Howard exhibits a machine for pressing hats and bonnets, which, in point of ingenuity of design, and excellence of workmanship, is not surpassed by any machine in the exhibition; it seems, in all respects, to be admirably adapted for its purpose, and we must regret that the late hour of its arrival, deprives us of the pleasure of awarding to it a premium, such as it well deserves.

Cottrall's lattice weighted bridge, possesses peculiarities which render it a fit subject for examination by the Committee of Science and the Arts.

Gideon Cox, of Philadelphia, exhibits a variety of specimens of wooden ware for household use, all of which are well made, and appear to be very well adapted to their several purposes. We recommend the award of a certificate of honorable mention to Mr. Cox, for the superior wooden ware exhibited.

Professor Cresson, of the Gas Works, deposits a small iron steamboat, called the "Coquette," which has two small horizontal engines, and has been run at the rate of seven miles per hour; it deserves notice, as adding another to the many successful examples of the

superiority of iron over wood, as a material for the construction of vessels.

Jordan L. Mott's stationary cowl, or ventilator, No. 7, of his advertisement, richly deserves a certificate of honorable mention, if not a medal, as Ewbank's experiments have proved it to be much superior to a cone, showing its apex to the wind, as well as to other forms in common use. Besides, being *stationary*, it neither *screeches* when the wind blows, nor is it at all likely to get out of order, there being no moving, or wearing parts.

In fine we think we can perceive, in the style of the workmanship on some of the machines now exhibited, a sure precursor of future triumphs for American artisans, so soon as the several branches of mechanical industry shall extend themselves further, and occupy more ground in the field of utility.

Report on Stoves, Grates, &c.

The Committee of Judges on Stoves, Grates, &c., have examined the numerous collection of stoves and cooking ranges, and have been gratified to witness the spirited competition which exists among the manufacturers of these important appliances of domestic economy.

This branch of manufactures appears to have attained to one of those stages of maturity at which the further progress of improvement seems to be for a season stayed. Certain general principles, founded on reason and experiment, have been developed and applied to practice, under so many modifications of form, that the ingenuity of inventors is at a stand.

The parlor and hall stoves exhibit under various forms, modified according to the fancy of the maker, but generally involving the principle of diffusing the heat of the fire over an extensive radiating surface; a principle of acknowledged excellence, but one which may be, and is sometimes, carried so far as to impair too much the draught of the fire. The stoves of this class which are thought most worthy of notice, are—

No. 1501, a radiator, by Pleis, Fœring & Thudium.

No. 1620, a radiator, by Jacob F. Pleis.

No. 1707, a radiator, by Weaver & Volkmar.

No. 1720, a radiator, by Williams & Hinds.

No. 1721, an air-tight wood stove, by A. Brenizer.

No. 1714, the crescent stove, invented and deposited by J. W. Kirke, is new and curious in its arrangement; it carries the principle of radiation to its utmost useful limit, and may probably be found to have its draught somewhat impaired by the attempt to obtain the whole heating effect of the fuel.

All of which are considered to be worthy of certificates of honorable mention.

The remarks made above as to the absence of any notable improvement, apply to the cooking stoves and ranges, equally with the ornamental stoves, all of which very much resemble those exhibited for the last two years.

No. 1608, a cook stove, by Durell, and No. 1698, by J. Kisterbock, are both of well known and approved construction, and may be considered deserving of honorable mention. The like distinction is due to No. 1686, a summer stove and baker, by M. Stewart, who has also deposited a double stove on the summer baker principle, which involves the trouble of making two fires in one stove, and is, therefore, not thought to be a judicious arrangement.

The cooking ranges exhibited are four in number, deposited respectively by Lloyd & Feltwell, Julius Fink, F. McIlvaine, and Henry Hallman; the two first named have already received the silver medal of the Institute at previous exhibitions, and, consequently, can now receive no higher mark of commendation than certificates of honorable mention. The other two bear a strong resemblance to each other, and approach so nearly in construction to the former, that they may with propriety be recommended to a like distinction.

In addition to the above, the committee would recommend the award of honorable mention to De Witt C. Mott, of New York, and to C. W. Warnick, of Philadelphia, for the extensive and creditable display of stoves, furnaces, boilers, &c., which they respectively contributed to the exhibition. All which is respectfully submitted by the committee.

Report on Cabinet Ware.

The Committee of Judges on Cabinet Ware, respectfully report as follows:—

It is a source of some surprise to your committee, that, in this city, where the manufacture of cabinet furniture is carried on to a remarkable extent, both in the variety, style, and excellence of workmanship, so limited a display should have been presented to the public eye on this occasion. Notwithstanding, however, the paucity in amount, many of the articles present beautiful models of taste, ingenuity, and excellence of construction; the workmanship, as usual, being of such superior accuracy as to challenge competition, and fully support the well earned reputation of this city, in this department of manufacturing industry.

The committee desire, especially, to call the attention of the Institute, to the centre table, and other articles, Nos. 1319 to 1321, made of American woods, as a branch of the arts deserving of its fostering hand. The workmanship justifies the encomiums bestowed by the public, and is worthy of the beautiful material employed, which cannot be excelled by the productions of this, or any other, continent.

These articles are recommended for the most favorable award within the ability of the Institute to bestow.

The committee would also call attention to the pointed, or Gothic, style of furniture, Nos. 1330 to 1332. Upon such articles as these is based the reputation of our city for superiority of workmanship, and the selection of tasteful forms, in which these articles can scarcely be

surpassed; they are recommended to the most favorable notice which the regulations of the Institution permit.

The committee would respectfully recommend to honorable mention, the articles in the florid style of Louis XVI, Nos. 1222 to 1225; this style has become somewhat the fashion within a few years, and although not based upon classic principles, and of doubtful taste, is highly ornamental. The articles are well made, the upholstery creditable, and of rich materials; the toilet table, particularly, being a very ornamental and tasteful affair.

To John Gibson, of Philadelphia, for the painting of a centre table in imitation of veined marble; of another, imitating various woods, and for a Gothic book-case, painted in imitation of oak, all of which painting is unusually well done, a certificate of honorable mention.

Finally, the committee recommend to honorable mention, the Venitian blinds, No. 1293, which are of much better finish than usual, and work well; in fact, these samples are the best which have come under the notice of the members of the committee, and richly merit the judgment given above.

The committee beg leave to close their report with the remark, that the articles, above enumerated, are all that merit particular notice, (as far as they are able to judge,) of the number exhibited on this occasion. Generally speaking, the Cabinet Ware, though limited in quantity, is equal in quality, if not superior, to that exhibited in former years, and all the articles (with few exceptions) are of such construction and finish, as will authorize us in maintaining the opinion given in the first paragraph of this report.

Report on Musical Instruments.

The Committee on Musical Instruments report, that they have examined the Piano Fortes in the exhibition rooms, with reference to the qualities of their tone, their touch, the regularity of their scales, the prompt action of the dampers, the principles of their construction, the character of the materials employed, and the entire workmanship. One of these, No. 1302, is a grand piano of the largest class; the fourteen others are of the ordinary form, though the action in many of them is that of the grand piano.

The grand piano is from the manufactory of Mr. Thomas Loud, but has been in use for some months as the property of the gentleman for whom it was made. It is, in many respects, remarkable; without, perhaps, any considerable peculiarities that can be called new, it appears to combine the best improvements that have been introduced in Europe, in the structure of such instruments, or that have heretofore been devised by Mr. Loud himself. It has great power and roundness of tone, the bass especially being remarkable for its force and purity; the damping is instantaneous and complete. In the disposition of its parts, as regards beauty, convenience of access, and strength in the materials used, and the neatness and efficiency of the

work, as well as the durability and exterior appearance of the instrument, it reflects high credit on the manufacturer.

Of the other pianos, very few were found below the appropriate standard of a good parlor instrument. The improvement of the art is, indeed, manifest in all of them; and several establishments have shown that they are now in such a state of advancement, as to construct instruments with the certainty that they shall be of the higher grades. After very often repeated trials of all the instruments separately, and again in competition with each other respectively, the committee unite in declaring their preference for the two pianos, marked No. 209, A, from the manufactory of Messrs. Gale & Co., of New York, and No. 1271, from that of Mr. Conrad Meyer, of Philadelphia; and a majority of the committee, as between these two, preferred the former.

The committee, however, abstain from recommending the grant of the Institute's medal, at this time, to either of the competitors. In this they by no means wish to detract from the meritorious character which belongs to their instruments; but they are of opinion, and they act upon the opinion, that this high honor should be reserved for instruments that disclose some distinct and important improvement in the principles of structure, or some singular combination of the points of excellence.

In the same spirit they do not recommend a grant of the medal for the guitar, No. 1346, made by Mr. C. F. Martin, of Nazareth, Penna.; this is an instrument of the Spanish form, graceful in its proportions, and of very fine tone. It was not made for exhibition, having been deposited by a purchaser, but it is so highly meritorious as to invite a special and complimentary mention.

The parlor organ of Mr. Corrie and others, No. 1269, attracted, for itself, much commendation. Its arrangement of the stops and pedals is, in some respects, novel, and allows of every possible variety of combination. The stop denominated the *Euphronia*, contrived somewhat on the principle of the claribelle, may yet be regarded as new. The whole structure of the instrument is handsome, and its tone good.

The serafina, No. 1178, is a very creditable instrument of its class, of rich tone, and suited, by its appearance, to the parlor.

The case of wind instruments, No. 1232, from the establishment of Mr. Weygandt, contains a number of fine flutes, flageolets, &c.; the merits of several of which claim the notice of the committee.

In conclusion, the committee remark, that a comparison of the specimens now before them, with those at the two last exhibitions, gives the most satisfactory proof of progress in the arts of constructing the different Musical Instruments.

Report on China and Glass Ware.

The Judges to whom was assigned the examination of the China and Glass Ware, respectfully report:—

That upon entering on their duties, they found but a meagre dis-

play of those wares, far short of what has usually been submitted to their inspection, and of what might reasonably have been expected. Philadelphia furnishes a market for a large amount of Glass Ware, and the manufacturers of the article would certainly have advanced their own interest had they submitted to the public, through this exhibition, a better variety of what they are capable of producing from their respective factories. It is to be hoped that at the next exhibition they will contribute more liberally.

From P. C. Dummer & Co., Jersey City Glass Company, deposited by E. E. Smith; this company makes the best display of glass ware in the exhibition:

No. 601, one large covered bowl, of cut glass, a beautiful piece of workmanship, but no further notice can be taken of it, because the depositor was not certain that it had not been exhibited before.

No. 601, one cut glass bowl, not so large nor so richly cut as the above, but of graceful form and finish, and decidedly superior in quality of metal. To this piece of ware the judges would award a silver medal.

Nos. 602, 603, and 605, several articles of cut glass, but none of them remarkable.

No. 604, one pair of moulded and cut claret flagons, a very fair article.

From the New England Glass Company, deposited by S. D. Hastings:

No. 613, several pairs of cut salts, rich and beautiful goods; there were some other articles, on the same stand, made by this company, but as they were not on the judges' list, it is presumed they were entered too late for competition. The judges were happy to perceive a decided improvement in the quality of the metal from this factory. To this company the judges would recommend a certificate of honorable mention.

No. 723, one pair of decanters, from the Boston and Sandwich Co., deposited by H. Tyndale. These were sufficient to show that this company maintains its superiority for quality of metal.

No. 652, a lot of glassware from Capewell & Brother, deposited by makers; no improvement on last year's display; there is in this lot a decanter with several apartments for different kinds of liquors, which will receive its meed of praise from the visitors to the exhibition, for its curious and ingenious construction.

No. 722, earthenware from the American Pottery Company, Jersey City, deposited by P. Wright & Son, the quality of the ware is fully equal to that exhibited last year. A cake jar, with a water lute to prevent the admission of ants, or other insects, is a well finished and useful article, deserving a certificate of honorable mention, but the depositor being one of the judges, prevents them from awarding a premium to it.

No. 646, earthenware made and deposited by Abraham Miller; the success that has attended the efforts of Mr. Miller in the manufacture of common earthenware, should prompt him to attempt a competition with the foreign article in the finer kinds. In glass ware a minimum

duty almost excludes the foreign article from our markets, and we trust the day is not far distant, when a like result will be attained in the earthenware manufacture. The display this year manifests an improvement that fully deserves a premium, but Mr. Miller being a member of the Board of Managers of the Institute, the regulations of the Committee on Exhibitions prevent the judges from awarding it.

No. 724, two porcelain baskets, made by Bagaly & Ford, deposited by H. Tyndale, a well finished article for American manufacture.

No. 614, window glass, made and deposited by T. Richardson; there is no competition in this article, which is much to be regretted. It is an important branch of trade, and the manufacture of it should be fostered with especial care. The sample exhibited is a pure material, free from waves, and deserves a certificate of honorable mention.

Report on Hats and Caps.

The Committee to whom the Hats and Caps were referred, beg leave respectfully to report:—

That with the exception of Mr. Donaldson, (who has not at any time been present,) they have carefully attended to the duty of examining the articles submitted to their inspection; but confess themselves utterly at a loss from the superiority of nearly all the articles shown, to form a judgment which might not appear partial; they also take occasion here to say that they have never seen, at any previous exhibition, or time, such quantities of the really well made and beautiful in all the departments of Hatting, and, whether color, quality, style, or workmanship be taken into consideration, your committee are of opinion, that the exhibition of the present year outvies all previous ones.

With one or two exceptions, we are happy to perceive the Hats and Caps are all placed in neat cases; this is an improvement which we think it would be well to insist upon in future exhibitions, on account of security, if for nothing else.

There are two or three invoices, the cases for which were sent to the rooms before 12 o'clock on Tuesday, but from ignorance of the rules, *or some other cause*, the articles themselves were not brought in until after that hour for record. Their quality is such, that we are of opinion, that in these instances a strict regard to rule may be dispensed with, particularly as we know that invoices of some Hats and Caps were entered *before*, and the goods brought in *after* the hour designated. These articles will be noted in their proper places, and the disqualification will then be also noted, that the Committee on Exhibitions may take the order which their judgment on these facts may dictate.

No. 952, a case of hats from James Huns, in Chesnut street, above Sixth; these hats are stated to be taken from the shelves, and are the hats ordinarily kept for sale by the exhibitor; they are of a good color, well made, handsomely finished and trimmed—they are beautiful hats.

No. 976, an invoice of three nutria, and three moleskin hats, from Mr. Orlando Fish, New York, deposited by Mr. Walborn; these hats, in the opinion of your committee, cannot be excelled in their quality, neatness of finish, and general workmanship. They are represented to have been taken from the shelves of Mr. Fish's store, and are his ordinary goods; they are a little heavier than the same kind of hats made in this city. We think they are entitled to honorary mention.

No. 997, several hats made and deposited by Mr. John C. Yeager, No. 163 North Third street; these are beautiful specimens of the art, trade, and mystery of hat making: very creditable to Mr. Yeager, very neat in their appearance, of excellent color, and for the prices placed upon them, cannot be excelled. We are of opinion an honorary mention is due.

No. 1001, one hat of nutria, and one of moleskin, made and deposited by Mr. John Hile, at the North-east corner of Chesnut and Eighth streets; these hats, the committee think, are deserving of commendation, from their lightness, beautiful finish, good color, and excellent style of trimming; their whole appearance is very creditable to Mr. Hile, as a maker of hats.

No. 1002, two children's caps of velvet, made by Mrs. Hile, the wife of the above named gentleman; they are said to be the product of her own hands; they are very neatly made, and the style is alike creditable to her taste and abilities.

No. 1005, a large assortment of hats, caps, and military hats, from Mr. Charles Oakford, Chesnut street; a portion of these goods being locked up, the committee could not subject them to the examination which most of the other articles have undergone; those which they handled are very fine in quality, very neatly, but not quite so elaborately, finished, as most of the other hats in the exhibition; the trimming is in Mr. Oakford's usual neat style. The military hats are (as might be expected) very showy, and exhibit great neatness in their getting up. The velvet caps are very pretty specimens of that kind of goods.

No. 1045, sundry hats, from Mr. Isaac Oakford, South Third street; these hats present the appearance of very well made articles, and are creditable to Mr. Oakford, as a new competitor for public patronage in his business.

No. 1047, an invoice of hats from Oliver Brooks, corner of Third and Walnut streets; these hats are excellent in all respects. Your committee beg leave to note more particularly a patent cassimere hat, exhibited by Mr. Brooks; this is made without seam, the body being made in the usual manner, and the covering made of fine wool, and drawn over the body without stiffening, all that is necessary, is to brush it in the same manner a garment is brushed when soiled. It is a great improvement in this article, that it is free from stiffening.

No. 1054, several hats from the store of Mr. Samuel Mears, in Market street; these hats are well made and got up, and are good specimens of the durable in hatting.

No. 1055, a large octagonal case of hats and caps from Messrs.

Lamberti & Blynn, Market street, near Tenth; Mr. Lamberti has been long and well known in this community as a maker of caps, and his goods have always been characterized by a neatness, and prettiness of style. Those exhibited are beautiful specimens in this respect. The hats are of different qualities, and appear to your committee very commendable for their finish, and, in fact, for all the good qualities of good hats.

No. 1062, from Preston Bishop, a case containing several hats; this case was locked up, and thereby a *feeling* examination could not be made; as far as the eye is of use in determining the nature of the goods, they appeared very well finished, neatly trimmed, and of good color.

No. 1069, one cassimere and one moleskin hat, from Mr. Bird, under the Franklin House; these hats present a very good appearance, well made, good color, &c., &c., in fact, they are what is now looked for in these days of improvement and competition.

No. 1070, one cassimere hat, made by Mr. Nickerson; a well made article, and neatly *got up*.

No. 1072, a case containing four hats, from the establishment of E. Kimber, jr., North Fourth street; these are of excellent color, well made, and neatly trimmed and finished. Your committee think Mr. K. deserving of great credit in the improvement apparent in all these respects.

On the top of this case are two fur bonnets, and one child's fancy hat, which are very pretty specimens of his handiwork in that line; an honorary mention, we think, is his due.

No. 1088, four hats, made and deposited by Mr. Charles Bulkley, whose establishment is under the Philadelphia Banking House; these hats were sent in and recorded a short time after 12 o'clock on Tuesday—the case coming in before. Your committee are of opinion that these hats are deserving of notice; the senior judge declaring he never saw better, and that it is impossible to surpass them in the brilliancy of their color, lightness, and general style of finish. From the relationship existing between the chairman of your committee and the exhibitor, he feels some delicacy in recording the views of the other members, but feels compelled by a sense of duty.

No. 1095, a case of velvet caps, from Mr. Brown, New York, in the same circumstances, in regard to time of deposit, as the hats named above; they are the prettiest article of the kind in the exhibition, in the judgment of your committee, and should be noticed.

No. 1120, two hats, two caps, and one child's fancy hat, from Charles F. Raymond; these are good specimens of Mr. Raymond's manufacture.

James Walker has two hats on stands, which are good specimens of workmanship, and creditable to him as a maker of hats.

Your committee believe they have carried out the views expressed at the commencement of this report, of bestowing pretty general commendation upon the Hats and Caps exhibited. Where there is such a uniformity of goodness, they do not think it just to pro-

pose a medal for any individual: it would seem as if the neatest and best of operatives had outdone themselves, in producing these superior articles. The improvements are owing, in part, to competition in trade, and more particularly to the impetus given by the Institute, which puts forth such inducements to artisans of all kinds to exhibit their handiwork. That the Institute may still progress in the laudable designs of its foundation, is the heartfelt wish of your committee.

Report on Chemicals.

The display of articles in this department is exceedingly beautiful, and reflects great credit on the depositors.

No. 309, a display of admirably prepared chemicals, from Messrs. Wetherell & Brother, among which the oxide of mercury may be designated as particularly good.

The oil of black pepper, and the salarine are also of very superior excellence. The specimens of crystals are also remarkably beautiful.

The exhibition is also indebted to Mr. S. Wetherill, for a highly interesting display of the various Peruvian barks, in their natural state.

No. 335, Smith & Hodgson also deposit a collection of very superior chemical preparations, among which the tannic and gallic acids, and narcotine are remarkable for excellence, and the cyanide of potassium and citrate of iron very good.

No. 327, Frederick Brown also deposits a beautiful case of chemicals prepared by Mr. Trumbull, among which the citrates of iron may be particularly designated.

No. 405, a lot of articles manufactured by Harrison & Brothers. The well earned reputation of these gentlemen is a sufficient voucher for the excellence of these preparations.

The committee were particularly pleased to see the acetate of alumine, the pyroligneous acid, and pyroliquate of iron.

No. 323, a specimen of beautifully crystalized acetate of lead, from the manufactory of Mordecai Lewis & Co., a very excellent specimen from these well known gentlemen.

No. 326, two bottles of cyanide of potassium, an article rapidly introducing itself into practice, as the solvent used in the process of galvanic gilding; a very creditable specimen of chemical preparation from the laboratory of Mr. Worthington.

No. 613, a case of pharmaceutical preparations, designed for the use of students of medicine, arranged and deposited by Edw. Parrish. The articles appear to be of excellent character, are neatly and substantially put up, and seem to be in every way fitted for the purpose for which they designed.

No. 635, a lot of chemical glass ware, made by Stephen Heintz, and deposited by L. Voigt; these articles appear to be excellent, and they unite the suffrage of all those who have used them. The forms of the bottles are well adapted to facilitate pouring, emptying, and cleaning, and every part of the apparatus appears neatly designed

and well executed. The committee did not test the graduations, believing that this will be best done by each purchaser for himself.

Among the articles not properly included among chemicals:

Nos. 306 to 308, loaves and jars of sugar, manufactured and refined without the use of blood, by Messrs. Lovering, of this city; this article is of a very superior character, and the committee consider it as well worthy the attention of the Institute.

No. 346, a box of excellent isinglass, from C. Delacour; this article was exhibited at the last exhibition, but was too late to come under the notice of the judges. It appears to be a very good article, and may be recommended to those who have use for it.

No. 373, some very beautiful glue, deposited by C. W. Gschwind; this has met with high approbation from all who are judges of the article. The committee strongly commend it to attention.

No. 388, adamantine candles, by Hancock & Mann, of Baltimore; this is a very beautiful article, which appears to be taking the place of the spermaceti candle.

No. 351, a lot of articles from Mr. Morfit, exhibiting the products of the various processes in the manufacture of stearine candles from lard; the specimens are highly interesting, and show, in a very clear light, the method of the manufacture. Mr. Morfit claims the discovery of a new method of purification without saponifying, about which claim the committee know nothing, but consider Mr. Morfit, (a very young man) as deserving all credit for his unremitting industry in perfecting and extending this important manufacture.

There are deposits of fancy soaps by Curtis Taylor & Son, No. 301.

Perfumery, by Jules Hauel, No. 324, and N. B. Hinton, No. 347, all of them excellent of their kind; but a great superiority in this article must be accorded to Mr. Roussel, No. 333, for his very beautiful and admirable exhibition of fancy soaps and perfumery. Mr. Roussel's merits have already been decided upon by a great many of our citizens, and the committee can say nothing which would add to his well earned reputation.

The committee recommend the following awards:

To Wetherill & Brothers, No. 309, Smith & Hodgson, No. 335, and Lawrence Trumbull, No. 327, certificates of honorable mention, for the general excellence of their chemical preparations deposited.

To Edward Parrish, No. 613, for the neatness and excellence of his pharmaceutical preparations.

To Stephen Heintz, No. 635, for the excellence of the chemical glass ware deposited by him.

To Lovering & Co., Nos. 306 to 308, for their display of steam refined sugar.

To Charles W. Gschwind, No. 373, for the excellence of his glue.

To Hancock & Mann, No. 388, for the beauty of their candles.

To Campbell Morfit, No. 351, for his interesting display of the various preparations of stearine.

To Eugene Roussel, No. 333, for his admirable display, and the general excellence of the articles manufactured by him.

Additional Report.—Our attention having been called to the article of Jeweler's Rouge exhibited, we have taken the pains to inquire of those who have used it, and find that they unanimously recommend it as a very superior article for jeweler's purposes. We therefore request to have added to our former report, the following recommendation.

For No. —, jeweler's rouge, to Mrs. Mary West, a certificate of honorary mention, for the excellence of the article.

Report on Straw Goods.

The Judges on Straw Goods beg leave to make the following report on the articles referred to them:—

No. 214, specimens of No. 5 and 7, Amazon braid, manufactured by A. Casseli, New York; the braid is purely white, exceedingly even and regular in texture, and of proper quality for the number. This article is deserving of high praise as a domestic fabric, and when made up, presenting a light, durable, and beautiful bonnet, equal, if not superior, in these respects, to any thing of foreign production. The committee would recommend to the manufacturer a certificate of honorable mention.

No. 215, Amazon braid bonnets, made up by S. D. Hall & Co., of New York, who are entitled to praise for the purity they have preserved in the color of the braid, in getting up a neat and tasty bonnet.

No. 1084, a glass case containing Amazon and Florence braid bonnets, manufactured by Thomas White, of Philadelphia; although received too late for competition, yet are entitled to much merit for the superior manner in which they have been made; equal praise is also due to the palm leaf hats, and hair edgings, by the same maker.

Daniel B. Legg has also deposited some hair edging, entitled to attention, but received too late for competition.

No further samples were presented to the committee worthy of mention; we would also further state, that, in our opinion, it is in bad taste to present for exhibition bonnets made up of braid, or other material, of foreign nature, and the more so when that braid gives much more than half the value to the bonnet.

The committee are sorry to add that they are much disappointed in the very poor display of the articles belonging to Straw Goods; the variety and quality is poor, and the quantity very limited. This subject is worthy of more attention by the manufacturers of our country, and we do not err in saying, that over a million of dollars have been paid in one year by the United States, to foreign countries for articles in this line, and even now many hundred thousand dollars are yearly lost to us in the same manner. We have in our land all the variety of raw material, and the specimens in other goods in this hall, certainly prove that our manufacturers have equal skill with those of other lands: we trust that at the next exhibition of this Institution, the Committee on Straw Goods may have no cause of like complaint.

Address of Dr. ROBERT M. PATTERSON, *at the close of the Thirteenth Exhibition of American Manufactures, held by the Franklin Institute of Pennsylvania, for the Promotion of the Mechanic Arts, October*, 1843.

Philosophers have long embarrassed themselves in the search after some characteristic difference by which man could be distinguished from the other animals, and which might constitute, as it were, the definition of our species. The power of *speech* has been selected for this purpose; but the babble of the parrot and the jay shows that this power does not belong to us alone. The possession of *reason* has been supposed to be peculiar to man, and to be a sufficient characteristic; but the man who, submitting to the evidence of his senses, will examine the various actions and devices of the inferior animals, many of them of such a kind and under such circumstances as to forbid a reference to blind instinct, and who yet will deny that they are capable of reasoning, must, I think, be himself greatly deficient in this boasted faculty. Another definition of man has been derived from his erect port, and his countenance raised to heaven, so that Aristotle thought he had characterized the species, when he defined man to be *a featherless biped.* But many of the apes, and particularly that caricature mockery of man, the ourang-outang, show that this definition is insufficient; and, you know, that to throw it into ridicule, Diogenes, the laughing philosopher, plucked the feathers from a cock, and, casting it into the school of the Stagyrite, exclaimed—behold the Man of Aristotle!

Franklin, whom we may, I hope without unpardonable irreverence, consider as the patron saint of our institution, has suggested another characteristic of man, and defines him to be *the animal that uses tools.* And, in fact, what is it that has constituted man the head and lord of the animal creation? We know that he is naturally weak; how then has he erected the massive temples, and the cloud-capped towers?—by machinery. He is by nature defenceless; what then has given him such power, that the lion and the tiger tremble before him?—his terrible instruments of destruction. He is naturally naked and exposed; yet by tools and machinery, he forms, from the wool and fur of animals, and the fibres of plants, clothing, so well suited to the circumstances in which he may be placed, that he inhabits, with comfort, every climate. His sight is limited; but, by the aid of instruments of his manufacture, his view is extended from the minutest atom, to the distant worlds which circle in the heavens. While other animals have the enviable faculty of traversing the air and the waters, he is naturally confined to grovel on the surface of the ground; but he has constructed the silken balloon, in which he may soar in safety above the clouds, and the majestic ship, in which the ocean is made his highway, and the winds his ministers.

Without pretending to consider this subject further, in the point of view in which I have presented it, it is impossible not to perceive, that it is to tools, implements, and machines, of various kinds, extra-

neous to man, and not furnished to him by nature, that he is principally indebted, not only for his control over the rest of the animal creation, but for his own immediate protection, comfort, and subsistence. It is evident, therefore, that to foster and promote the mechanic arts, must be ever one of the most rational and effective means of advancing the interests of society.

Under this impression, and with this purpose, the Franklin Institute of Pennsylvania was founded, twenty years ago; and how much has it not already accomplished! Its professed objects are, as you know, to advance the useful arts, and to improve the condition, character, and prospects of the industrious class of citizens by whom they are exercised; and the means by which it proposes to accomplish these objects, is the general extension of useful, practical knowledge. The workman who understands nothing of the principles of his trade is rather to be termed a *machine* than a mechanic, and will certainly never make any improvement in his business.

Of the means of acquiring a knowledge of any mechanic art, there is one which cannot be brought within the province of the Institute, but which yet occupies a high rank; it is the instruction which is obtained in the workshop, under the direction of a master. It becomes us to be upon our guard against the ridiculous boast of those who call themselves self-taught. It is a fallacy and a deception. Examine the matter closely, and you will find that self-taught means half-taught. He that undertakes to teach himself a trade, is sure to have an ignorant master.

But if a trade be confined to what is learned during apprenticeship, it can never be improved. The ambitious mechanic and manufacturer will not be content to follow in the exact footsteps of his master; for it is a pregnant truism, that he who always follows must always be behind. The intelligent artisan, will, therefore, not fail to extend his inquiries as widely as possible; he will seek to learn what improvements have been made in tools, machinery, processes, and materials, at home and abroad, and he will make a study of those sciences which have a bearing upon his trade, while he will be cautious how he rejects any accessible knowledge because he may not see its immediate connexion with his business.

Of the means employed for the communication of knowledge, *books* are certainly among the most important. It is with as much justice as force, that printing has been called the mother of the arts.

The formation of a library was one of the first objects proposed by the Institute, and it has persevered in it constantly and successfully, so that now its collection of books is large and valuable, and opens to the members sources of information on almost every subject likely to excite their interest. Besides the larger works in the library, European and American periodical publications are taken, on the various subjects cultivated by the visiters to the reading room, and the journals of the day are also laid on the table, so that the reader cannot fail to spend his evening in a manner which shall be at the same time amusing and instructive, and, let me add, innocent.

A journal devoted to the objects of the Institute has been conducted under its patronage almost from the time of its foundation. I have no hesitation in saying that it has been, and is, a most useful work, worthy of all encouragement. To suppose that such a publication can be conducted in a way which shall suit the particular tastes and objects of every reader would be absurd. The founder may take no interest in the polishing and varnishing of woods, and the cabinet maker, might, perhaps, willingly dispense with a long essay upon alloys. It is the business of the editors, however, to cover, as far as possible, the whole ground of the useful arts, and to give to every man a just share of the matter which most concerns and interests him. In this respect, I think that the journal has been conducted with skill and discretion; and, knowing it to be calculated for extensive usefulness, we hope that it may not fail to command your continued and increasing support.

But it must not be supposed that books, although they are certainly among the most essential vehicles of information, are always sufficient for the purpose. There are many departments of knowledge which books alone are not able to communicate. These require the exhibition of experiments, of models, of drawings; and they require to be illustrated and enforced by oral instruction. The Institute has accordingly procured sets of philosophical and chemical apparatus, a valuable collection of models, and an extensive cabinet of minerals. It also, in its earliest days, established the necessary professorships; and courses of lectures, on various important subjects, are delivered annually. A series of these courses is now about to be commenced at the Hall. They will comprise the subjects of Mechanics and Physics, by Professor Cresson; of Elementary Chemistry, and of Geology, by Professor Frazer; and of Chemistry applied to the Arts, by Professor Booth.

Natural Philosophy and Chemistry may be considered as forming the essential ground work of the useful arts. The mechanician who is ambitious of laying claim to a skill in his business which is more than the result of mere habit and imitation, must not neglect the study of those sciences. So important, indeed, have they been considered, that it was principally for the sake of making them accessible to practical workmen, that this Institute was originally established. Of the gentlemen who now hold these professorships, I will let public fame speak, for I know how distinct is her voice in their favor. As to myself, I am free to acknowledge that the warm predilections of personal friendship make me an unfit witness.

Another most useful department of instruction is presented in the Drawing School. To what embarrassments are not our workmen and mechanicians often exposed, from their ignorance of this most important art? With what awkwardness and difficulty do they express their ideas of machines, buildings, furniture, and a thousand other objects, merely because they cannot draw. Indeed there is scarcely a trade in which the possession of this art might not prove beneficial, and its more general cultivation is therefore greatly to be desired.

The professor in this department is Mr. William Mason, who, to the skill of an artist, adds the experience of a teacher.

In enumerating the means of communicating information presented by the Franklin Institute, it would be an unpardonable neglect, on my part, were I to omit the labors of a branch of the Institution, comprising a large body of its best informed and most active members, and organized under the title of the Committee of Science and Arts. It is, in truth, the Scientific Board of the Institute, and, as such, its transactions have been of the most important character. I offer, as examples, the admirable investigations on water-wheels, and on the explosion of steam-boilers, of which the reports are given at large in our journal. As to the latter, it seems to have nearly exhausted the subject; at least I have not seen that the expensive experiments since made by the order, and at the cost, of the Government, have added any thing of importance to our knowledge in this matter. But these were special labors of the Committee. Its ordinary business is of a different character. It is its duty to investigate the merits of every invention, claiming to be original, and offered to its consideration, and to make written reports of the conclusions to which it has been led. A long connexion with this Committee has enabled me to witness the importance of these investigations and reports. In numerous instances, they have served to bring into public notice neglected results of inventive talent, and thus to encourage and reward true merit. In many others, the projector's expectations have proved to be ill-founded, and he has been advised to abandon his schemes, and has been thus saved from useless expenditures. But of all the results, the most usual is, that ingenious contrivances, truly inventions of the applicants, and believed by them to be new, prove not to be original, but to have been invented by others before them. Such information is of great importance to the supposed inventors, by preventing them from taking out patents which cannot be sustained, and thus saving them from loss and litigation.

The last of the means of information and improvement, employed by the Franklin Institute, to which I shall call your attention at this time, is the establishment of public exhibitions, to which the mechanics and manufacturers of the United States are invited to send the productions of their several branches of business. The first of these was held twenty years ago. I remember it well. It was given in the lower story of the Carpenters' Hall; and limited as was the space, it still presented "room and verge enough" for all the articles that could be collected. We were proud of this exhibition; we thought it eminently successful; we boasted of the advancement which it showed in our domestic arts and manufactures. What a land is this that we live in! Improvement makes its progress among us with locomotive speed; and twenty years ago is an antiquity when viewed in connexion with our country's advancement. Let those among you, who, like myself, are old enough to deal in reminiscences, compare the meagre display of our first exhibition with the noble richness of our last; of that which now fills the vast saloons of this great building, and which you have all been viewing, I am sure, with

pleasure and with pride. How wonderful is the contrast! Yet it is but an index of the improved condition of our country. This colossal structure does not more exceed the old Carpenters' Hall—this latest exhibition does not more exceed the earliest—than do the products of our skill and industry exceed those of a period but four short lustres since.

It is no part of my task to give an account of the present exhibition. This has been already done in an interesting report from the appropriate Committee, which was read by their chairman, Mr. Weigand, on Tuesday last. On this occasion the opinions of the judges were announced, and medals and certificates awarded, which, as care is taken that they be given to the most deserving, may well gratify the ambition of the successful competitors.

And now, ladies and gentlemen, I have laid before you, as briefly as possible, an account of the measures adopted by the Franklin Institute, for carrying into effect the objects for which it was founded; and I have directed your attention, in the last instance, to the evidence of progress in the useful arts, presented by this, our Thirteenth Exhibition of American Manufactures.

If we take a wider view of this last subject, we shall see that the great improvement witnessed here is but an example and a part of a general increase in the means of extending the comforts and luxuries of life which has taken place over the whole civilized world. It is true that these benefits are very unequally distributed; yet can it not be doubted that the average condition of mankind is raised and improved by the increased facilities of production and manufacture. Who is there at the present day, that cannot be comfortably fed, lodged, and clothed, if, indeed, he be not degraded and impoverished by vice? And as to the luxuries of life, how wide now is the circle over which they extend. The imperial Elizabeth of England had to be content with rushes strewed over the floors of her palace; scarcely have we now a mechanic so poor as not to indulge himself in the luxury of a carpet. This desirable improvement in the physical condition of man has gradually increased, and is still increasing; and with the vast resources which nature has placed at our disposal, it is hard to conceive the limits by which it is to be bounded.

What then is the magic influence by which this important purpose has been, and is to be, effected? It is not by labor alone, nor is it by science alone; but it is by their union. "Practical mechanics," says Sir John Herschel, "is, in the most pre-eminent sense, a *scientific art;* and it may be truly asserted, that almost all the great combinations of modern mechanism, and many of its refinements and nicer improvements, are creations of pure intellect, grounding its exertion upon a moderate number of very elementary propositions in theoretical mechanics and geometry. It would require not volumes merely, but libraries, to enumerate and describe the prodigies of ingenuity that have been lavished on every thing connected with machinery and engineering. By these it is that we are enabled to diffuse over the whole earth, the productions of any part of it; to fill every corner of it with miracles of art and labor, in exchange for its peculiar com-

modities; and to concentrate around us, in our dwellings, apparel and utensils, the skill and workmanship, not of a few expert individuals, but of all, who, in the present and past generations, have contributed their improvements to the processes of our manufactures. The transformations of chemistry, also, by which we are enabled to convert the most apparently useless materials into important objects of the arts, are opening up to us every day sources of wealth and convenience of which former ages had no idea, and which have been pure gifts of science to man. Every department of art has felt their influence, and new instances are continually starting forth of the unlimited resources which this wonderful science developes in the most sterile parts of nature."

It should ever be an aim, then, of those who would improve their race, to bring science to the aid of manual labor; and such, in fact, is the great purpose and business of our institution. This, then, is a fitting time and place, for coming out in the defence of intellectual labor. But is this necessary? Yes! It is not to be denied that a prejudice (though happily it be a diminishing one) exists against what is contemptuously called headwork. It is looked upon by many as no better than idleness, and men who do not work at a trade are too often viewed with jealousy, as mere consumers of the produce of others' labor. So far has this been carried, on some occasions, that attempts have been made to put down these idlers, and to resist their acknowledged influence in society; and, for this end, political parties have been formed of persons calling themselves the *working men. The* working men, forsooth! And who, in this community, except a few dandies and loafers, are not working men? Is it the lawyer, who, after years of preparation, is now spending his days in the court room, and his nights in the office, in anxious, responsible, and fatiguing business? Is it the physician, who, in the exercise of his arduous and painful profession, wastes his own health that he may restore yours, and endangers his own life that you may live? Is it the minister of religion? Is it the engineer? Is it the teacher? Is it the merchant? No one could be so preposterous as to suppose it. Where then are we to find this envied class of individuals—this race of nobles—who, while in idleness themselves, are living on the labor of others? If you would find them at all, you must look for them—in the Alms House!

Let me assure my hard handed friends, that their envy of professional men is unfounded. These men should rather be objects of their pity; for of all the varieties of labor to which we can be exposed, the labor of the mind is the hardest. I will appeal to almost any mechanic to say, whether, of the many duties of his business, that of making up his accounts, and posting his books, is not the most irksome,—that which, of all others, he is most apt to postpone, even to his own injury. Yet is such a task mere play, in comparison with the true intellectual labor of the mental workman. What college student would fail in his task, of Greek, or mathematics, if it could be performed by any bodily exertion. Depend upon it, if learning could be attained by sawing wood, or breaking stone, the world would be filled with

scholars. If now there be but few, it is because few can withstand the pain, the fatigue, the wearing down of the constitution which accompany continued mental labor. Why, even the weaving of words and sentences into such a fabric as may not be altogether unfit to be presented among the articles of this exhibition, is harder work, and requires for its execution a longer apprenticeship, than any labor of the hand-loom.

Those profound thinkers who direct their labors immediately to practical purposes, and who do so with success, are sometimes happy enough to secure, at once, the respect and gratitude of their fellow men. Arkwright, the inventor of the spinning-jenny, gave rise to a revolution in manufactures, which has had more influence upon the destinies of the earth, than all the wars of Napoleon. Watt, by bringing to perfection the steam engine, created, and subjected to the service of man, a race of Titans, the obedient and legitimate slaves of his will. Such services are obvious, and are appreciated. But the pursuits of science are by no means always of this character. The philosopher is generally led forward in his investigations, not by any immediate views of practical utility, but by that strong impulse of *curiosity*, which God has been pleased to implant in a few superior minds, appointed by himself to give light and knowledge to the world.

Now sordid and ignorant men are in the habit of ridiculing these men, and their occupations. When they see the mathematician poring over his symbols, to them more unintelligible than the hieroglyphics of Egypt,—when they see the mineralogist collecting stones, and the botanist peering at flowers and weeds by the way side,—when they see a Franklin flying kites, and a Newton blowing soap bubbles, they sneer at the trifling occupations, and superciliously demand—*cui bono?*—what is the *use* of all this?

Now, the terms *good* and *useful* are very difficult to define, and will be differently applied by different persons. For my own part, I would give a high place among the advantages of knowledge, to the *pleasure* which it is capable of affording us. Pleasure—innocent pleasure—is itself a *good*, and he who presents us with a new source of pleasure, confers a benefit which may be truly called *useful*. Even the rigid utilitarian acknowledges this, provided the pleasure be to his own taste, though he may scorn the mere intellectual enjoyments of the philosopher. An example will show this:

Some years ago, Sir David Brewster invented an optical instrument, familiar to you all, called the *kaleidoscope*. In this contrivance, by means of repeated reflections from two plane mirrors, an object, without regularity or beauty in itself,—made up of broken beads, crooked pins, and the like,—had its image multiplied in the sectors of an entire circle, so as to present a form beautiful from its perfect symmetry. This instrument, capable of presenting such pleasing images, and of varying them to infinity, was in every one's hands, and excited universal delight; and Brewster might boast of having solved the problem of the Roman Emperor, and invented a new pleasure. Yet our satisfaction was continually interrupted by the remark:—well, this is

very pretty, to be sure, but what is its *use?* At last some Birmingham and Manchester men bethought them of using the instrument to suggest figures for carpets and paper hangings, and our houses were ornamented with kaleidoscope patterns. At once the utilitarian was satisfied, and acknowledged that the kaleidoscope had made itself useful. He did not reflect, that, while the figure on the floor, or the wall, was not half so beautiful as its optical prototype, it was also not a whit more useful: but then he had a taste for domestic ornaments, and none for philosophical experiments.

Investigations having their origin in pure curiosity, and which often reward their projectors only by the pleasure which arises from the discovery of new facts, are, when fully prosecuted, seldom, if ever, barren, in direct applications of practical importance. Such consequences, often very remote, are not, indeed, the inducements which lead the lover of science in his labors. For him, the instinct of curiosity is sufficient. But as practical utility is a test required by the mass of men, I agree, for the moment, to submit the pursuits of the philosopher to this trial; and in the selection of examples, I am embarrassed only by the multitude which press themselves upon my notice.

My first is taken from an old experiment in chemistry. Never, perhaps, was there a man possessed of a more insatiable curiosity than Roger Bacon. He was constantly applying to nature to teach him her secret mysteries, and he interrogated her in the only language to which she will answer—the language of experiment. In his day, the false science of alchemy was in vogue, and thousands of combinations were tried, in order to discover, if possible, some method of forming the precious metals. The research was vain as to its intended object, but not always so as to other practical results. Numerous important facts were observed, which laid the foundation of the true science of chemistry. Among these, Bacon discovered that if charcoal, sulphur, and saltpetre be combined, they form a mixture which explodes by fire: this mixture is *gunpowder.* The experiment was undoubtedly a curious one; but could any man, at that time, have anticipated its tremendous consequences? Yes: there seems to have been one, and it was Bacon himself. His prophetic mind suggested to him the terrible applications that could be made of his discovery, and he did not dare to take the responsibility of putting such an instrument of mischief into the hands of his fellow men. He concealed his discovery in an enigma, which he terminated by the tantalizing words—"et fias tonitru, si scias artificium;"—that is, to give a free translation,—"and you may produce thunder, if you can find out my secret." The secret *was* found out, and the discovery, to which the curiosity of Friar Bacon had led him, produced a revolution in the world. A new power was created which would tear solid rocks asunder. The fleetest animal could not escape the swift messenger of death propelled by gunpowder, and the most savage dared not to contend with it. Weapons wielded by personal strength became insignificant in comparison with the superior force of fire arms; and the whole system of

war, by which the destinies of mankind have been so much governed, was changed.

Many years before the commencement of the Christian Era, some curious observer discovered, that when amber was rubbed, it acquired the property of attracting light bodies to it, and holding them suspended. For ages this remained an insulated and unprolific fact, and the experiment was considered a trifling one by all but those who had learned that no truth is unimportant. At length the experiment was resumed. It was found that many other substances possessed the same property as amber. The apparatus was enlarged, and new phenomena were presented,—light, and heat, and sound being produced. Means were then found for collecting, and, as it were, bottling up the mysterious agent of these phenomena, and effects of the most astonishing kind were presented. In a word, discovery after discovery was made, until the new science of *Electricity* was offered to the wonder of mankind. The electricity accumulated in large machines, and particularly in the Leyden battery, exhibited appearances and produced effects which seemed to simulate the lightning, though in a feeble degree, and the identity of the two was suspected. Our own Franklin, who had acted a conspicuous part in the science, had a curiosity not to be satisfied by mere speculation, and he determined to test the suspected identity by direct experiment. For this purpose he adopted an expedient characteristic of his mind, which seemed always in a playful mood, even when laying the foundations of a science, or of an empire. He made a common boy's kite; surmounted it by a metallic point, of which he had himself discovered the remarkable electrical properties; depended upon the hempen cord, with a key fastened to the end of it, for his conductor; and insulated the whole by a twine of silk to be held in the hand. Aware of the ridicule which so falsely attaches itself to such pursuits, he went secretly to a common on the skirts of this city, and raised his kite. A promising cloud passed over, and electricity was eagerly sought for in the apparatus, but none appeared; and disappointment and chagrin threatened our philosopher, when a shower fell, and the wetted cord became a better conductor. The knuckle was again applied to the key; several distinct sparks of electricity were given off, and the great discovery was completed. It was proved that the lightning which charged the clouds, was the same substance as that, which, in the amber and glass, had raised the wonder of the philosopher, and the sneers of the utilitarian. The thrill of pleasure which this experiment excited in the breast of Franklin, was not confined to him alone. The discovery was hailed with enthusiasm over the whole civilized world. And what produced this universal feeling of pleasure? It was the gratification of an intense curiosity. No one could be so dull as not to desire to know the cause of the terrific phenomenon of the thunder storm, and the Philadelphia experiment told to the world this great secret of nature. Was not this enough? Must some matter of fact man chill the general enthusiasm by his cold inquiry—*cui bono—what's the use?* Yes: the inquiry *was* made, and most triumphantly was it answered; for the discovery met immediately with its practical

application, in the invention of the lightning-rod, that noble contrivance which gives us security amidst the most frightful turmoil of the elements, which robs the lowering thunder cloud of its terrors, and lays the red bolt of Jupiter harmless at our feet. The discovery of Bacon brought weapons from the infernal regions, to carry death among the ranks of men: the discovery of Franklin disarmed heaven of its artillery, for their preservation.

If philosophers, in the investigations which they undertake, cannot foresee the practical conclusions to which they are to lead, they have yet too many proofs, such as the above, of the utility of all natural science, to permit them to doubt that their pursuits are to bring about good, as well as gratification. It is the dull and ignorant only, who, utterly incapable of receiving pleasure from the discovery of truth, also doubt, or affect to doubt, its importance. How signally is their scepticism often refuted by the most unexpected results! Of this, let me ask your attention to one other example.

The gases, which are transparent and colorless, present no exterior appearances by which they can be distinguished, and they were accordingly all confounded with atmospheric air. Little was it suspected that they really differed as much from one another in their properties as do the metals, or any other bodies; but at last the investigations of pneumatic chemistry proved this to be the case. Among the experimenters in this department, the earliest after Black, and the most successful of all in the discovery of facts, was the celebrated Priestly. His curiosity on the subject was insatiable, and led him to the most singular researches for its gratification. Among these was the examination of the noisome air which rises from stagnant pools. Methinks I see the supercilious dandy turning away his offended nose and resorting to his pouncet-box, and the coarse groom bursting with unrestrained laughter, as they see the old philosopher raking the mud of a horse-pond, and carefully collecting the gas which bubbles up from the bottom. How absurb an occupation, in the eyes of ignorance! Now mark the discoveries of which this was the first step. The gas is taken to the laboratory. It is found to be inflammable, and to be much lighter than atmospheric air. Analysis proves that it is a compound of hydrogen and coal, and it is named carburetted hydrogen. It is obtained from other sources, and particularly from the distillation of bituminous coal, which yields it in great abundance, and also in greater purity. Thus far curiosity has led the research, and its gratification has been the only reward; but now begin the practical applications.

The gas is found to burn with a bright flame. The happy idea is suggested of using it for lamps instead of oil. The experiment is tried upon a small scale, and is perfectly successful. The scale is boldly extended. Immense laboratories are built; huge gasometers are erected; iron pipes are laid for miles in extent; and to every part of the largest cities there is conveyed a source of light which rivals that of day. The effect is wonderful—is magical; and the utilitarian is forced to acknowledge that it is also most beneficial.

But another application of this gas has been made to a purpose no

less astonishing. Of all the attributes in which other animals excel man, (and they are not a few,) there is perhaps none so much a subject of desire, I may almost say of envy, as the power which the birds possess of flying through the air, while we are confined to the surface of the earth. Accordingly, means of traversing the air have been eagerly sought after in all ages, and the history of inventions furnishes us with numerous records of vain attempts to attain this object. The problem was at last solved, in part at least, by the air-balloon, which consists, as you know, of a large reservoir of silk filled with a gas lighter than the atmospheric air. Now, the gas which we have been considering, possesses this property, and from the ease and economy with which it can be made in large quantities, is the best calculated for this purpose. By its aid man can be transported through the air on silken wings, soar to a height from which he might look down upon the Andes, and return to the earth in perfect safety. He can more than realize the fable of Icarus, and without its fatal termination.

The system of gas-lights, and the air-balloon, are two of the proudest triumphs of science and art. Let me call upon you to look back, from the exhibition which I have made of them, to the picture which I first presented, of a little man in black, curiously engaged in the apparently childish occupation of gathering air bubbles from a stagnant pool. The occupation of Priestly was *not* childish. He was in search of a jewel more precious than the diamond. He was in search of *truth*. He found it; and it now occupies a brilliant place in the diadem of jewel truths which crown the memory of a philosopher, to whom Pennsylvania has the honor of having afforded first an asylum from persecution, and then a grave.

I have now laid before you the views which led to the establishment of the Franklin Institute,—have pointed out the means which it employs for carrying these into execution,—and, in doing so, have found it necessary to defend the labor of the mind from the accusations of ease and inutility. We have seen that the great principle which serves, with most assurance, to advance the useful arts, and to improve the condition of man, consists in combining the work of the intellect with the work of the hand; so that what the researches of science have produced as abstract truths, the hands of labor may turn into results of practical advantage. Labor and science, if in singleness, may be regarded,—the former as a sturdy bachelor, rejoicing in his thews and sinews,—the latter as a maiden, conspicuous for her beauty and attractions,—but both barren. Joined in the bonds of a holy union, they are prolific of good, and their offspring are individual comfort, plenty, and refinement, and national strength, independence, and prosperity.

And now, ladies and gentlemen, it only remains for us to thank you, as the honored representatives of the Philadelphia public, for the favor by which we have been sustained amidst our arduous though voluntary labors, for the patronage with which our exhibition has been honored and rewarded,—and for the kind attention which we have received from you, in this our closing scene.

Mechanics, Physics, and Chemistry.

In the "Journal für Praktische Chemie," for May, 1843, an essay appeared by Carl Hochstetter, embracing a series of experiments on Sugar, subjected to various actions, and chiefly designed to develope the action of the substances contained in the juice of the Sugar-beet, as well as those with which the Sugar is brought in contact in the course of manufacture. The first part of the essay referring only to the Sugar-beet, we shall confine ourselves to the subsequent portion, which will apply to the manufacture of Sugar generally. J.C.B.

Behavior of pure solutions of Sugar under different actions and circumstances; by Carl Hochstetter. *Translated by* Oehlschlager, *and communicated to the Journal of the Franklin Institute by Wm. M. Davis.*

Both in the tropical and home manufacture of sugar, the sugar obtained by expression, or maceration, is only partially preserved in its original state, that is, as cane-sugar. Even before it had been proved to a certainty, that the sugar-cane, and the beet, contained only cane sugar, it was admitted that a large portion of the molasses of the sugar refiner, is to be attributed to a change of the cane-sugar under different influences during the process of preparation.

The early fermentation of saccharine vegetable fluids, which have been expressed a phenomenon very common in the manufacture of sugar in the tropics, proves the action of the nitrogenous substances contained in these juices, for, as far as our present experience goes, they alone can produce those changes which we denominate fermentation.

The observation that after the continued boiling of a solution of sugar, only a part can be preserved as sugar fit for crystalization, points out heat as another agent, or influence.

There is no doubt that the influence of such agents diminishes the yield of the refiner; but I doubt whether a correct judgment has been formed of them, and without this, improvements in the manufacture of sugar are not possible.

To obtain this end experiments had to be made on a small scale. These I made by trying to submit solutions of sugar to the influence of the same agents to which the sugar in the juice, and during the whole process of preparation can be submitted.

In consequence of the insufficiency of chemical expedients to separate the newly formed kinds of sugar from the cane-sugar, and to determine their quantity, I found it impossible to ascertain the exact degree of decomposition which I observed under different influences. It is true that more recently the polarization of light has been applied to determine the quantity of the different kinds of sugar in a solution, and the degree of transformation of the sugar under different influences; I, however, did not apply this method, as it could only be of use to me in a few observations, but would be entirely inapplicable for the greater part. I moreover doubted the correctness of the re-

sults in these cases, for reasons to which I shall revert hereafter. The results of this method, as given in the works of Ventzke,* and Soubeiran,† I have, however, constantly compared with my own.

I.—*Influence of atmospheric air upon a pure solution of Sugar, at a common temperature.*

Sugar dissolved in pure distilled water can be preserved for weeks in closed vessels, without undergoing any changes; but if, on the contrary, we expose a solution of about 10° B., to the air in a tumbler, and protect it against dust, we find already after three days, traces of altered sugar, which increase daily. This fact had been observed before, and the change in the second case had been attributed to the organic substances contained in the air.

But whatever probabilities may favor this opinion, it would almost appear that the atmospheric air had an immediate share in bringing about these changes, for pure solutions of sugar, a large part of which is exposed to the air, change in a very short time. The following experiment will show this to be correct:

I filled a glass cylinder, open at the top and at the bottom, with broken glass, like an acidulating vessel for the quick vinegar process, and gradually dropped a pure solution of sugar, the purity of which I had before ascertained by the copper test, slowly, and in such manner, into it, that the air found unimpeded access. The liquid running out below, I continued to pour in at the top. The temperature of the surrounding air was 15° R. After six hours labor I found already altered sugar, for, on mixing with it sulphate of copper and alkali oxidule, (protoxide of copper) was separated. This change increased rapidly, and after 36 hours of operation, the decomposition had progressed so far, that, on evaporation under the air-pump, first, no crystalization was obtained, and after many trials, only a very sparing one. The liquid had remained colorless during these trials, but had become somewhat dimmed.

Whether the effect is produced by the influence of the oxygen of the atmospheric air, or by the organic substances, this experiment proves that considerable contact with the atmospheric air, can change a pure solution of sugar.

Influence of heat upon the pure solutions of Sugar in boiling.

A solution of sugar boiled for some time, or exposed to a temperature above boiling water heat, decomposes itself, as has been observed by many, and loses its power of crystalization. At the same time several new substances are formed, such as uncrystalized sugar, by some called sirop sugar, and noticed as a peculiar kind of sugar, formic and acetic acid, ulmic and ulmic acid.

These changes and transformations, under the influence of water and of heat, progress very slowly. To obtain a distinct view of the changes of a solution of sugar in boiling, a continued action of several hours is requisite. Many experiments made on a large scale, almost

* See Journal für Pr. Chemie, vol. xxv, p. 65, and vol. xxviii, p. 101.
† See Journal für Pr. Chemie, vol. xxvii, p. 281.

made me doubt the pretty generally received opinion, that the greatest part of the molasses obtained in the preparation of sugar, is sugar destroyed by heat. The previous experiments, where sugar solutions had been boiled for twenty-four hours and more, could not be considered as a practical standard; I therefore made the following experiments several times:

A solution of pure sugar of 25° B., I boiled in an open bowl at one trial for 1 hour, at another for 1½ hour, and at a third for 2 hours, and in such a manner that the evaporated water was not replaced until the temperature of the boiling mass had reached 110°—112°C. Even after two hours boiling in this manner, the mass remained colorless; left under the air-pump for crystalization it proved very copious. The liquid, after having been separated from the crystals for some time, formed a solid mass; but decomposition had taken place notwithstanding, for the test by copper showed traces of uncrystalized sugar, and when heated with lime-water the liquid changed to a yellow color. This experiment, repeated frequently, always produced the same result. When the solution of sugar is boiled in an alembic, the sugar undergoes a greater change than in the bowl; the time that the sugar is under the influence of heat being the same. It is difficult to account for this, for we might more readily suppose, that, as the air finds freer access to the bowl than to the alembic, the contrary would be the case. Perhaps this difference of behaviour, when boiling in the alembic, is caused by the flowing back of the water of condensation, which itself aids in the decomposition of the sugar through fermic acid, which cannot be known by any test.

This may be the cause that Soubeiran, in his experiments, after the effect of a boiling heat of two or three hours, discovered considerable decomposition. In boiling sugar for a longer time, it becomes evident that the decomposition, under a more protracted influence, proceeds more rapidly than in the beginning of the experiment, because the products formed by the first action, aid in the decomposition of the sugar, and the more of these there are formed, the more will the transformation be accelerated.

According to Soubeiran, a solution of sugar decomposed by boiling, reacts strongly acid, and, in this case, the acceleration of the process of decomposition can easily be explained. I have not been able to ascertain whether a solution of sugar, which had been boiled for a long time in an open bowl, reacted as an acid upon litmus paper, yet there are in this liquid, acid products, which, as soon as alkalies are introduced, immediately destroy the alkaline reaction. Mixed with calcareous earths, we obtain partly indissoluble compounds. The formation of volatile and *non-volatile* acid products is incontrovertible, and from this we may deduce, that fruit and grape sugar must be formed in the same manner as when acids act upon cane sugar. The opinion that a peculiar kind of sugar is produced by the decomposition of cane sugar, appears to me, therefore, very hazardous. Ventzke* calls this sugar sirop sugar, and mentions, as its peculiar

* See Journ. für pr. Chemie., vol. xxv, 2nd series, p. 75.

quality, that it does not polarize the light. If we compare the phenomena, which accompany the transformation of sugar during ebulition, with the effects of diluted acids, we shall find considerable analogy, for in both acid products are the result. We may also take it for granted, that as soon as acid products have been formed, they exert their influence in such a manner as to generate fruit and grape sugar, and other productions. The perfect neutrality of the mass of sugar, examined by Ventzke, may, therefore, be accounted for on the principle, that grape sugar and fruit sugar existed in such proportions as mutually to destroy their power of polarization. A separation, or isolation, of these two kinds of sugar has hitherto been found impossible, by crystalization it would scarcely be possible to separate them.

To observe the influence of atmospheric air upon a boiling solution of sugar, a solution of 15° R., was boiled in an alembic, and a continued stream of atmospheric air guided through the boiling liquor, by means of a forcing pump (aspirans.) The influence of the air could not be mistaken here, for in less than one hour and a half the saccharine fluid had become considerably darker. The test by copper indicated a considerable decomposition, and the crystalization of the sugar, under the air-pump, was more difficult, leaving behind a darker colored sirop, than in those experiments where the boiling solution of sugar had not been similarly exposed to the air, for, in boiling in the open air, the generated steam prevents the contact with the air.

These experiments prove that the action of the heat in boiling solutions of sugar on a large scale, under the same circumstances, and during the period of ebulition, produces no observable effect when the solution is pure; but that the action of the oxygen of the air aids materially in effecting a transformation in the cane sugar.

Behaviour of the solutions of Sugar under the influence of Alkalies.

That cane sugar combines with alkalies, that from this combination it can be separated again by acids, without any alteration in its form, is known.

In the manufacture of sugar the combination with lime is of great importance; although it has often been demonstrated that lime stands in the same relation to sugar as all the other alkalies, yet the general opinion that large quantities of lime added to the saccharine vegetable juice destroys the sugar, is still prevalent among a large number of sugar refiners. To ascertain this point, and, at the same time, to obtain a knowledge of the behaviour of alkaline solutions of sugar under the influence of different agents, the following experiments were made:—

I prepared sugar lime, by digesting a solution of sugar with caustic lime, at a common temperature, and, after filtering it, I obtained a liquid saturated with lime, and as clear as water; of this I made use in all the subsequent experiments.

When this solution of sugar lime was mixed with carbonic acid, heated to a boiling heat, to drive off the excess of carbonic acid, and the liquid was separated, by filtration, from the carbonate of lime,

which had been formed, I obtained, after evaporation under the air-pump, a sugar perfectly pure, which, when dissolved, and the test of copper applied, did not show a sign of decomposition. Another part of this solution of sugar lime I boiled for two hours constantly over a free fire, always supplying the evaporated water; after which time I used carbonic acid in the decomposition, and the sugar made its appearance as in the foregoing experiments. One part of the solution of sugar lime I reduced by evaporation in a china bowl over the lamp, keeping it constantly boiling; the temperature rose to 120° C., (248 Fahr.) As the mass at this point became so thick, that I could not stir it, it was partially burnt, and the smell indicated the products which sugar forms when distilled dry with alkalies; after cooling, the whole mass was hard, so that it could be reduced to a powder. I separated the white pieces from those which had became brown, and had suffered by decomposition; the former dissolved in water without any residuum, and when decomposed with carbonic acid, did not present the least appearance of sugar incapable of crystalization.

These two results agree with the results of Soubeiran, according to which, sugar combined with alkalies resists the effects of heat better than the pure solution of sugar.

When a concentrated solution of sugar lime is for some time exposed to the air, the sugar may also be separated unchanged; but hereby a peculiar phenomenon is observed. The mass gradually attracts carbonic acid from the air, without carbonate of lime being separated as a precipitate; at last the mass becomes transparent like a jelly, and under the air-pump assumes the appearance of a transparent gummy substance. On attempting to dissolve this mass in water, large quantities of carbonate of lime are separated; the same occurs when the moist, jelly-like mass is diluted, or heated, with water.

That a solution of sugar will decompose carbonate of lime, is a known fact, but these quantities are so small, that they cannot be compared with those found in this case. Whenever I tried to dissolve newly precipitated carbonate of lime in concentrated, or diluted, solutions of sugar, or of sugar lime, I always found that only a small portion of the fluid had been absorbed; when I introduced carbonic acid into a solution of sugar lime, a precipitate of carbonate of lime would form immediately.

Why, in the above mentioned case, when the absorption of carbonic acid proceeded very slowly, no carbonate of lime was separated, I am not able to explain; but the phenomenon is interesting enough to be examined more carefully.

Concentrated, or diluted, solutions of sugar lime, which have been a long time exposed to the air, generally become somewhat darker, but even when they assumed the color of white wine, I could never discover decomposed sugar. The color is undoubtedly produced by organic substances, which, introduced from without, have been decomposed by calcareous earths.

Effect of neutral Salts upon the pure solutions of Sugar.

When alkaline chlorides, neutral alkalies, alkaline sulphates, and

alkaline carbonates were brought in contact with solutions of sugar, no other phenomena appeared than those which are observed in pure solutions of sugar under different influences.

The salts, however, interfere with the crystalization of cane sugar, particularly chlorides, and it appears as if they entered into actual combinations with the sugar. Péligot pretends to have obtained a crystalized compound of common salt and of cane sugar, other chemists have not succeeded with this experiment. Mitscherlich does not admit of a combination of common salt with sugar. I have not attempted to produce such a compound, but have limited myself to discover how far these salts are injurious to the crystalization of sugar.

In a solution of sugar to which I added two per cent. in weight of common salt in *one* experiment, and, in another, the same quantity of chloride of calcium, I could, by no means, produce any crystalization. When the mass is dissolved in water, and treated cold with much bone-black it crystalizes again, but it then only contains very small quantities of these salts. Alkaline carbonates have the same effect. Saline sulphates and carbonates partially crystalize from a solution of sugar, to which they are added in considerable quantities; a portion of them, however, form a greasy mass with the sugar. When added in very small quantities, as much as two per cent., they injure the crystalization of the sugar, but not as much as the chloride.

Influence of substances containing Nitrogen upon a pure solution of Sugar.

According to our experience, the presence of nitrogeneous substances is an absolute condition to produce in the solution of sugar fermentation, either vinous, acetous, or mucous; no saccharine vegetable juice is deficient in this respect, for all are capable of fermentation under certain circumstances. This power of decomposing sugar by the so called fermentation, does not belong to any particular nitrogenous substance; but it has been observed that animal, as well as vegetable, albumen, casein, gluten, and generally the substances containing protein, can exert the same influence.

Another change remains to be mentioned here, which cane sugar undergoes through nitrogenous substances, and which must be of interest in the present case. H. Rose,* namely, has found that under the influence of fermenting substances, cane sugar, before the commencement of vinous fermentation, is transformed into another kind of sugar, namely, grape sugar,† and that cane sugar is not capable of immediate fermentation. It is very probable that not only the vinous fermentation is preceded by this change, but that all the other similar transformations of the cane sugar, are, in the same manner, preceded by a transformation into a kind of sugar capable of direct fermentation.

The general conditions of fermentation are a temperature above the

* Poggend. Ann. of Phys. and Chem. vol. li, p. 293.

† According to Ventzke, fruit sugar.

freezing point, to about 40° R. (122° Fahr.) and access of the atmospheric air to the substances which affect each other.*

Access of atmospheric air is not only a condition to produce vinous fermentation, but also to effect the so called mucous fermentation. Mucous fermentation is easily formed in the expressed juice of the sugar cane when the air has free access; when excluded, no change takes place.

This is the basis of Apert's method of preserving vegetable juices. Péligot received from Martinique, cane sugar in its original state; the fresh cane juice had been heated to a boiling heat, and put in bottles whilst hot—the bottles had then been waxed. When this juice is taken out of the bottles, a mucous fermentation soon takes place. A similar experiment has not yet been made with the juice of the beet. The conditions under which nitrogenous substances are capable of producing the spirituous, milky, or mucous, fermentations, have not yet been ascertained. Boutron and Frémy have made an important contribution to the knowledge of the circumstances under which the milky fermentation takes place, in a very interesting work.† This work was particularly interesting for me, as milk fermentation is one of those changes which the juice of the beet manifests most frequently.

In the beet root we find vegetable albumen, and a number of other substances containing nitrogen; of the latter it has not been ascertained whether they belong to the compounds containing protein, and if they are fit to effect changes like these. That cane juice and beet juice possess the qualities of fermentation, is a well known fact. The only thing to be ascertained is whether, among the nitrogenous substances, the quality of inducing a change belongs solely to the so called albumen.

Let us first examine the phenomena which appear in the juice of the beet. When exposed to the air, immediately after expression, it frequently turns mucous very soon; it undergoes the mucous as well as the spirituous fermentation. On examining this altered juice, we find lactic acid, mannite, a gummy mass, and sugar, which cannot be crystalized. The juice of the beet may be preserved for twelve hours and longer, without any material change, but when once the process of decomposition has commenced, it proceeds rapidly; the smallest part of fermenting beet juice mixed with fresh beet juice, induces a change in a few hours. The juice of beet from which, by boiling, a considerable part of the nitrogenous substances, have been removed, manifest almost the same qualities as fresh beet juice; when exposed to the air it undergoes mucous fermentation, when the juice contains much or little free alkali. When the alkalinity of the juice has been diminished by acids, sometimes a spirituous fermentation takes place; but if we take the juice, although containing alkali, and moisten with it bone-black, press this mass into a glass, and keep it in a favorable temperature, a short time will suffice to produce spirituous fermentation, but no other.

I attempted to observe these phenomena on a small scale, by means

* Berzelius' Chemistry, vol. viii.

† Ann. de Chim., Juillet, 1841, p. 257.

of the two nitrogenous substances, which I prepared from the precipitates of the beet juice with lime. By bringing a solution of sugar into contact with the calcareous substance, the liquid generally became weak, sour, and somewhat mucous, after a few days. Acid lactæ, and a gummy substance, which could be precipitated by spirits of wine, had formed; mannite I could not discover in these experiments. The substance insoluble in water, the albumen of the beet, brought in contact with a solution of sugar, induced similar changes, but not until after a greater lapse of time. The products were the same, a part of the albumen, before insoluble, was soluble, and could be precipitated by tannin. When the sugar solution was made weak by alkaline, and brought into contact with these substances, the alkalinity disappeared after a while, and the decomposition became the same as before. When I made the solution of sugar strongly alkaline, no change was observable for a length of time. In all these cases I observed that the cane sugar changed into another kind of sugar, and this before any signs of fermentation appeared. This change was very evident when I brought a solution of sugar of 10° R., to which I had added some of the calcareous substances, into free contact with the air, by means of a cylinder filled with glass, as before described. After a few hours all the cane sugar seemed to be transformed into another kind of sugar, without indicating the formation of any other products. Continuing this process for a sufficient time, the liquid at last became slimy, but not sour. In this case, the substances containing nitrogen, seem to operate in the same manner as in the formation of vinegar from wine. Acids, and principally mineral acids, can prevent the fermentation under these circumstances. By heating a solution of sugar, which contains nitrogenous substances, to boiling, or by boiling it for a long time, it does not lose its fermenting properties, as I have stated before: clarified beet juice ferments very easily. Beet juice which had been evaporated to 25° R., and had, therefore, been exposed for a long time to the action of the heat, changed completely when left alone in a bottle for some considerable time. Carbonic acid was generated, and forced the cork out of the bottle; after a fortnight the fermentation ceased, and it afterwards appeared, on examination, that neither spirits of wine, nor acids of any kind, had formed. The product was principally mannite, and a gummy mass which could be precipitated by spirits of wine in the watery solutions.

When bad cane sugar from the colonies is dissolved in water, and left to stand in a favorable temperature, it produces a phenomenon quite similar to that mentioned above, only that in this liquid I could find no mannite, undoubtedly because too much other sugar prevented its separation.

All these phenomena are the results of the influence of nitrogenous substances; wherever similar phenomena appear, such substances will be discovered. Substances containing nitrogen may produce effects different from those mentioned just now at a higher temperature, that is to say, in contact with boiling solutions of sugar, or at temperatures a little above the boiling point of water.

It is a known fact that when a concentrated solution of raw sugar

and one of loaf sugar is left for some time in a temperature of 110°, the raw sugar solution changes much more than that of refined sugar. The supposition that in this case a direct transformation is effected in the sugar, by the nitrogenous materials contained in the mass, is not improbable.

This opinion obtains confirmation from the following experiment: Take a simple solution of sugar, and a solution of the same sugar clarified with blood; boil both for the same length of time, and the clarified solution will soon become discolored, whilst the simple solution remains colorless. In every clarified solution of the sugar refiner, even where the purest sugar has been used, we find substances containing nitrogen, which can neither be precipitated through tannin, nor this reagent (the blood.) It is possible that the clarified solution may be free from these substances, when very fresh blood is used; this remains to be tried, for it is certain that the older, and the more impure the blood, and the more albumen is changed by putrefaction, or whatever else this decomposition may be called, the greater will be the quantity of nitrogenous matter contained in the clarified solution; nor is it unlikely that the albumen of the blood, during the process of clarifying, is, by the influence of the heat, so changed, that it either coagulates no more, or when coagulated, dissolves again.*

I obtained the same results when I mixed and boiled a pure solution of sugar with the calcareous substances, frequently alluded to. The solution became of a darker color, and the test by copper indicated the formation of another kind of sugar. In this case the substance containing nitrogen had evidently changed, for, on continuing the boiling for some time, lime water, indeed, produced a precipitate, but only a trifling one, whilst nitrate of mercury produced a very abundant precipitate; before boiling, the substance could be perfectly precipitated with lime.

The products which are formed in this decomposition of nitrogenous substances, I have examined no further. I should suppose that during this change, ammonia is generated and emitted, whilst the remainder of the elements combine to form acid products, and effect the same changes on the sugar as all acid substances do. The brown color of sirop is mainly attributable to such products of decomposition.

The behaviour of substances containing nitrogen, during ebulition, and at higher temperatures, as in concentrated solutions of sugar, has been but little examined as far as I know. Only a few substances, lime and albumen, have been observed under similar circumstances, and have been found to change. In these experiments, the substances came only in contact with water, and the temperature was consequently not much above 100° C.; at higher temperatures the behaviour will be probably somewhat different, because, in general, some of these bodies are decomposed with more or less facility, accordingly as their elements are grouped more or less densely.

From what has been said before, we may conclude that the nitrogenous substances of the beet, and probably those of the sugar cane, can exercise different influences every where at the common tem-

* See Berzelius Lernbrech der Chemie, vol. viii, page 792.

perature, when these juices are left to themselves, and exposed to the air; and further, by heat during the process of boiling.

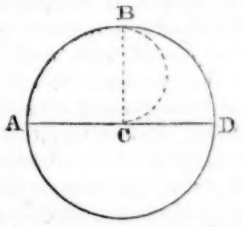
To be Continued.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On the Strength of Cylindrical Boilers. By Thos. W. Bakewell.

It is not my intention to prolong this discussion beyond a few remarks, on an unexpected denial by "E," in the October number of the Journal, of a proposition stated in my reply, (vol. vi, page 210.)

The estimate of the force to rupture, by the theory I advocate, is fair matter of dispute; but the proposition, above referred to, is the legitimate product of the received doctrine. In calculating the parting force, by the received theory, it is necessary either to suppose that the vessel containing the steam, possesses sufficient stiffness and strength to be unalterable in its shape, *independently* of any form which may give it this quality; or, what is the real state of the case, and the source of error, to overlook this circumstance altogether. Therefore, the transverse section, or diameter, determines the parting force, without regard to the form of the ends of the vessel on either side said diameter—that the direct force of the steam, perpendicular to the diameter, and such part only of the oblique forces as may be resolved into direct, are operative in parting the vessel at the diameter—and that the remaining forces derived from the oblique, being resolved into a direction parallel with the diameter, need not be taken into the estimate. The proposition made by me, presents the figure, or segment, of a boiler, A, B, D, C, attached at A and D, to a solid body, C. The substance of my averment, was, that by the received theory, the force to part at B, was half that exerted at A or D. "E." admits that the diameter governs at A and D, and that the whole force is sustained, one-half each, by A and D; but denies the applicability of the rule to the diameter, B, C, of the figure; or that the *half only* of the amount of force on A, D, is borne jointly and equally by B and C. Draw the semi-circle, as shown, on B, C, for the termination of *that* end of the figure, and let the line, B, C, be a tie bolt, considered sufficient to preserve the shape.



Can this change, in the form of one of the ends of the figure, vary the parting force by the steam at B? but the semi-circles on B, C, and on A, D, are similar, and under like conditions.

If it be said, the tie bolt, to preserve the shape, and perpendicular to the considered direction of rupture, lessen the strain at B, then, indeed, do we approximate in opinion; but as this admission cannot be looked for from "E," I maintain that the proposition is incontrovertible,—viz., that B, sustains half, and only half, of the force on diameter, B, C, in like manner with A D, as to their diameter. I wish it to be well noted, that the force to part at B, by the *received* and

rejected theories, is respectively as half the versed sine, C, B, to half the arc, A, B, D, and by raising the chord, A, D, parallel with itself, towards B, we can press the contending theories to their ultimata, and see whither they lead us; for the rule will hold till the chord, in advancing, obliterate the arc. I trust that "E" will not "jump to the conclusion," that I undervalue the facility with which he expresses himself in algebraic notation; but to those who see this subject as I do, his solutions fail in effect—wanting, as we conceive, that essential element to correctness—the consideration of the flexibility of material.

The preliminaries on which to found an equation are not agreed, and algebra cannot reason, or furnish ideas, although it afford a concise and convenient form of expressing them, be they correct, or erroneous.

Cincinnati, November 10th, 1843.

American manufacture of Wire Ropes for inclined planes, standing rigging, mines, tillers, &c. By JOHN A. RŒBLING, C. E.

The art of manufacturing ropes of *wire* is comparatively new. Numerous attempts have been made in Europe and here, and most of them have proved failures. A collection of parallel wires, bound together by wrappings, in the manner of a suspension cable, is no rope, and not fit for running, it can only be used for a stationary purpose. The first rigging made in England, was of this description. The difficulty in the formation of wire rope, arises from the unyielding nature of the material; iron fibres cannot be twisted like hemp, cotton, or woolen; their texture would be injured by the attempt. To remove this obstacle, some manufacturers have resorted to *annealing*, and thereby destroyed the most valuable properties of iron wire, viz., its great strength and elasticity.*

My first attempts in the manufacture of wire rope, were made four years ago; my intimacy with the construction of wire cable bridges, induced me to investigate this matter. The principles of my process differ from those of the English manufacturers—they are original and secured by patent. The novelty of my proceeding chiefly consists in the spiral laying of the wires around a common axis *without twisting the fibres;* and secondly, in subjecting the individual wires while thus laying to a uniform and forcible tension under all circumstances. By this method, the greatest strength is obtained by the least amount of material, and, at the same time, a high degree of pliability. Each

* By the term elasticity, I mean the property of wire to stretch and give when subjected to a strain, and to resume its former length after the strain ceases, without suffering a permanent elongation. The extent of elongation of iron is in proportion to the tension. In estimating the strength of a rope, the strain it has to support should never exceed the limit of elasticity. A permanent strain requires some more allowance.

The elongation of good wire of No. 14, 15, or 16, amounts, according to my own experiments, to 1-5000 of its length per ton per square inch. A strain of 15 tons upon a rope of 1 square inch section, and 1000 feet long, will produce an elongation of 3 feet. The limit of elasticity for working rope, I have assumed at 15 to 20 tons per square inch, according to the size and quality of the wire. A greater strain will produce permanent elongation, and if repeated, at last a rupture.

individual wire occupies exactly the same position throughout the length of a strand; another result of the precision and force applied in laying, is the close contact of the wires, which renders the admission of air and moisture impossible.

Three years ago I offered to the Board of Canal Commissioners, which was then in power in Pennsylvania, to put a wire rope of my manufacture on one of the planes of the Allegheny Portage Railroad, at my own risk and expense, the value of the rope to be paid in proportion as it rendered services equivalent to a hemp rope. This liberal offer, however, was rejected, and not considered until the present Board came into office. Last year I put three ropes, measuring, in the aggregate, 3400 feet, 4½ inches circumference, in operation on plane No. 3. Owing to the want of adhesion, I had, at the start, to contend with some difficulties. By means of a double groove on the receiving sheave, and a guide sheave placed back of it, which crosses the rope, and leads it from one groove to another, which improvements were added to the machinery last winter; I succeeded in doubling the adhesion. When, in unfavorable weather, there is delay and slipping on the other planes, the wire rope can at all times pull as heavy a load *without* a balance, as the engine is capable of hauling. The planes of the Portage Railroad require hemp rope of 8½ inches circumference, made of the best Russia, or Italian, hemp, and which cannot be trusted longer with safety than one season. They are frequently, from reasons of economy, continued 1¼ seasons; much, however, depends upon the weather and business. The unfavorable circumstances under which the wire rope had to work last year, affected it some; the wear of the whole of this season, however, is not perceptible, and its present condition promises a long duration. I am now manufacturing another wire rope of 5100 feet long, in four pieces, for plane No. 10.

The first rope of my make, 600 feet long, 3¼ inches circumference, has now been in successful operation two seasons, hauling section boats from the basin to the railroad at Johnstown. Two more were put to work last spring, at the new slips, at Hollidaysburg and Columbia. From my present experience, I may safely assert, that *wire rope* deserves the preference over *hemp rope* in all situations much exposed, and where great strength and durability is required.

By my process of manufacture, the same pliability is imparted to the rope which is proper to the wire itself. Paradoxical as this may appear, it is nevertheless a fact, and is easily explained. By pliability, is here understood the extent of flexure to which the rope, or wire, may be subjected, without producing a permanent bend; when released the rope must resume its former and straight position. To bend a rope requires force, and this force is in proportion to its areal section, *cæteris paribus.*

Well manufactured iron rope is *more* pliable than hemp rope of the same strength. I am manufacturing tillers of fine wire, capable of bearing 3000 lbs., and which ply around cylinders as small as four inches in diameter, and in which the wires are so compactly laid, that not the slightest shifting in their spiral position is to be observed. A

number of my tillers are in use on the Ohio and Mississippi. Such rope would be pliable enough for running rigging, and be of long duration.

I will here add a few remarks on the introduction of *standing wire rigging*, in place of *hemp rigging*. This subject has, for some years past, engaged the attention of the Navy Department of England and France, and the success which has attended the use of wire in place of hemp for shrouds and stays in the naval and commercial service of Great Britain, would, it appears, seem to warrant an attempt to test its utility in our national vessels.

Allow me to cite here a few remarks from the notes of Capt. Basil Hall, on a tour through Switzerland, and while examining the wire suspension bridge at Freiburg. He says, "attempts are now making, and will ere long succeed, to introduce wire rigging, which is stronger and better than *chain*, because less dependent on the accidental quality and careless manufacture of a single part. How strange it is, that the plan of making *wire bridges*, so successfully adopted in France, and elsewhere, should not have found favor enough in England to be fairly tried on a large scale. Freiburg bridge, 301 feet *wider* than Menai, at least equally strong, has cost only one-fifth of the money. I do not think wire will answer for running rope; but for standing rigging it may, I conceive, be most usefully substituted for hemp, for, with equal strength, experience shows it to be lighter."

The cables of suspension bridges are stationary, and will, when protected against oxidation, last an indefinite period. Standing rigging, when compared to running rope, is nearly stationary, and there is little wear but what arises from the direct strain, which, if supported by sufficient strength, will have no deteriorating effect. In comparing the two materials, wire and hemp for rigging, the state of preservation, and time of use should be considered. For instance, a hemp stay of a certain size, made of the best Italian hemp, will, when new, possess two-thirds of the strength of a wire stay of the same weight per foot; but let the two stays have been exposed, and served five years, then the strength of the hemp stay will be gone, while the wire stay will not show any perceptible reduction. In this case, of course, a common wear and tear is supposed.

The most prominent features of wire rigging, as compared to hemp rigging, are its great durability, less weight and size, less surface exposed to wind, less danger in time of action of being destroyed by shot. Another good quality of the wire rope is its great elasticity, which is quite sufficient to counteract the effect of a sudden jerk while a vessel is rolling heavily at sea. The elasticity of hemp rigging is only to be relied on to a very small extent; it will give and stretch a great deal, but not return.

A common objection of those not familiar with the nature of wire rope, is its supposed rapid destruction by oxidation, but no apprehension is less founded than this. Running wire rope, while in use, either in or out of water, in mines, or any other situation, will not even require the protection of oil, varnish, or tar; while at work it will rust no more than a rail, or a chain, in use; but when idle, oxi-

dation will affect it in proportion to the surface exposed. As, however, the process of laying is carried on with mathematical precision, by which the wires are brought into the closest contact, the assemblage of wires in form of a strand, present a solid rod, which will be no more subjected to rusting, than the link of a chain of the same size. The individual wires, as well as the strands and ropes, are coated with an excellent varnish during the manufacture. Wire rigging will require no other protection but oiling, or tarring, once or twice a season. Where elegance is an object, black or green paint may be used. Rigging made of zinced wires, and not painted, would present a most beautiful appearance, and be exempt from all rusting.

Wire rope can be spliced in the same manner as hemp rope. The attachment of wire shrouds to the sides of the vessel, and to the mast-head, and their connexion with the rattlins, (which should also be of wire,) can be effected by the old method; the use of wire, however, will suggest some modifications better adapted to the material.

Some wire rigging has been manufactured in England, which simply consists of a collection of parallel wires bound together, and served over with hemp. These mixtures, as experience has proved in the case of tiller-ropes, are objectionable—the wire will rust inside of the hemp in spite of all protection by varnish; besides the cover of hemp, which adds nothing to the strength, is only an additional expense.

Iron is now gradually superseding wood in the construction of vessels, a complete revolution in ship building has already commenced in England. Although very expensive at first, iron ships will prove cheapest in the end. Are there any well founded objections to wire rigging, which assumes the same relation to hemp rigging, as wooden ships to iron ones? There are none. Why then not test this matter by encouraging those who are capable of bringing it to perfection? A number of iron vessels are now building for the naval and revenue service, which seem to offer appropriate occasions for the test of this matter.

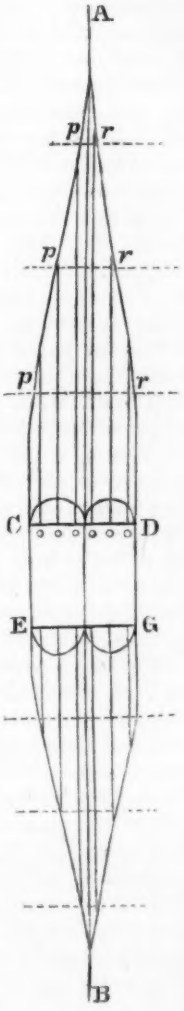
Saxonburg, Pa., September, 1843. Amer. Rail Road Journ.

The Forms of Ships.

The great importance of naval architecture induces us to return to the report of experiments conducted by a committee of the British Association for the Advancement of Science, which was read at their last meeting at Cork. The account copied into the last number of our *Journal*, from the *Athenæum*, was chiefly limited to the notice of the experiments themselves, and merely adverted casually to the deductions founded upon them, without describing the form of least resistance, which the committee recommend as the result of their five years' labors. We have since been supplied with a further account of Mr. Scott Russell's exposition, and, as the experiments have been more numerous, and have been conducted on a larger scale than any previously made on the subject, we think it desirable, in the absence

of the voluminous report of the committee and drawings, which may not be published for years, to state at least some of the results of these long-continued and costly experiments.

In Mr. Scott Russell's exposition of the labors of himself and Professor Robison, after mentioning minutely the mode in which they had conducted their experiments, and their results, he proceeded to describe the form of construction which they had determined to be the best, not only as offering the least resistance to motion through smooth water, but also as best adapted for rough seas. It is to be regretted, however, that in this, the most important part of his exposition, Mr. Russell was less explicit and not so minute as in describing the preliminary experiments. He stated facts, but did not explain the principles by which they were regulated, therefore it is difficult from one isolated form of construction, which was all he exhibited, to determine how far it is adapted to vessels of other sizes. He observed, that the great point which, in the first instance, was endeavored to be gained, was to get rid of the wave at the bow, which has the same effect in retarding a vessel as if it were immersed so much deeper in water. It was found that this object might be attained by lengthening the ship, and that whenever speed was required, there must be an absolute length without regard to breadth.



Mr. Russell having stated that each velocity has a corresponding form and dimension peculiar to that velocity, he exhibited the form of the light-water line of a steam vessel intended to be propelled with a velocity of 17 miles an hour, and explained the mode of constructing it. Suppose the breadth C D, of the vessel to be 25 feet, there must be set off forward from the greatest midship-section 120 feet, and for the after-part, 85 feet. To make room for the engines, there is no objection to putting in a piece in the middle of the vessel, called the middle-body, of equal width to the greatest midship section. On half the breadth of the vessel, fore and aft, describe the semicircles C, D, E, G. Divide the fore part, *o* A, into a given number of equal parts, and divide the semicircles also into the same number of parts; in the accompanying diagram, we have divided them into not more than four, for greater distinctness. Then draw lines parallel to the keel, A B, from the division *o*, *o*, *o*, of the semicircles to the cor-

responding divisions *p*, *p*, *p*, and *r*, *r*, *r*, of the keel, and the points where the lines intersect show the form of water-line required. The form thus attained, it will be observed, is very sharp both fore and aft, though the after part, or run, being shorter, is necessarily more full than the entrance of the vessel. This form is much opposed to the ordinary practice, inasmuch as the line is hollowed out, or partly concave, instead of being of the convex form, or full bow, which old ship-builders so much admire.

Having thus described the form of the light-water line, Mr. Russell promised to give the view he entertained of the principle on which the superiority of its construction depended; in this particular, however, he failed to make himself very clearly understood. He first alluded to the notions entertained of the manner in which the water is displaced by the motion of a vessel. It is commonly supposed, by ship-builders, that the water passes round the vessel; some imagine that the fluid is rolled under it; whilst, according to the French philosophers, the impact of water obeys the same laws as the impact of solid bodies, and the water is reflected from the bow at an angle equal to the angle of incidence. From the latter assumption they deduced that a round full bow is best adapted to meet with least resistance. It had been proved, however, in the course of these experiments, that the particles of water displaced by the bow of a vessel move into new places, that peculiar motions are given to them, and that they never return to their former positions. The motion of displacement, also, was found to be not confined to the vicinity of the vessel, but to have an extensive effect in a region anterior to the bow, and extending to a considerable distance on each side; and some time before the bow approaches a particle of water, the fluid has commenced moving. Viewing the sea as composed of innumerable verticle columns of water, the effect of the approach of a vessel is to produce greater pressure on one side of such columns than on the other, and water being, practically speaking, incompressible, the particles pressed against can move only in a vertical direction, and thus a heaping up of fluid is produced before the bow of the vessel, sometimes ranging as far as half its length. The next object the committee had in view was to examine the direction of the motion of the particles of water displaced by a vessel. It was found that when the form was that of least resistance, the motions of the particles of water were in semicircles; and that they deviated from that curve when the form departed from that of least resistance. It was also determined, that the replacement of the water as a vessel moved forward, takes place entirely from below. The result, therefore, to be attained, as appeared from these experiments, was to ascertain the form of the solid of least resistance, which would communicate these motions to the particles of water. In experiments on the forms of waves, conducted also at the expense of the British Association, it had been ascertained that the motion of water itself is that which the committee had endeavored to give to the water when ships pass through it. Thus it happened, that the form best adapted for least resistance in smooth water, being itself the form of the waves of the sea, the vessel of that shape moved through the sea with the

least motion and the least resistance. The consequence was, that in the course of these experiments it was found that a vessel built in the form of least resistance in smooth water, instead of being, as was formerly supposed, likely to be wet and uneasy in a rough sea, in fact passed through the waves without doing more than modifying their motion, and that in proportion as ships approach to the form of least resistance, they were dry, easy, and good steering boats. The concluding experiments were made on ships of 2000 tons, differently formed, and the same law which was found to prevail in smaller vessels was also followed in the large ships and in the roughest seas.

We have endeavored on the foregoing report, to give as intelligible an account of the deductions from the experiments on the form of ships as could be collected from Mr. Russell's exposition. It is evident, however, that there are many points of importance not sufficiently elucidated; and though the principle on which the advantages claimed for the wave form is attempted to be established as regards easiness of motion in a rough sea, the reason why that form is the one of least resistance in smooth water, is by no means clear.

It is a very difficult, and perhaps an impossible task to extract the pith from a voluminous mass of papers, calculations and drawings adapted to differing circumstances, so as to present, in a comparatively small compass, a satisfactory view of the whole; nevertheless, we wish to arrive at some fixed laws, and the principles on which they are founded. It appears that in all the experiments the object aimed at was to ascertain the form of least resistance in *cutting through* the water, and that no attention was bestowed on the form best adapted to cause the vessel to glide over the head-wave. The experiments, however, which were made a few years since on the Scotch canals with passenger boats, in which we believe Mr. Russell himself took part, show that the head-wave may be prevented by the boat being raised in the water by the oblique impact of its bow with the fluid.

Civ. Eng. and Arch. Jour.

Mechanics, Physics, and Chemistry.

Patent Case.—Winans vs. *The Boston and Providence R. R. Co.*

We are particularly indebted to B. R. Nichols, Esq., of Boston, Counsellor at Law, for furnishing the following synopsis of a recent patent case, in which his Honor Judge Story decided some points of interest to inventors and patentees in general.—Com. Pub.

An action in favor of Ross Winans against the Boston and Providence Rail Road Corporation was tried in the U. S. Circuit Court, before the Hon. Judge Story, at Boston, in November last, for a violation of a patent granted to Mr. Winans on the 20th October, 1831, "for an improvement in the construction of the axles, or bearings, of rail way or other wheeled carriages."

In the specification annexed to his patent, he states that he has invented an improvement in the construction of the axles, or bearings, of rail way or other wheeled carriages, in which, instead of forming the bearing under the body of the carriage and within the naves or

hubs of the wheels, there to sustain the weight of the load, he extends the axles out at each end, projecting beyond the naves to such a length as shall enable him to form them into gudgeons—the length and diameter of these gudgeons he regulates according to the load they are intended to sustain, and to other circumstances. In all cases, however, the value of his invention depends upon the gudgeons having their diameters as small as due attention to the strength required will allow. He then states various advantages in this mode of constructing axles and gudgeons, and that this improvement was exhibited by him in an experimental rail way in 1827, and put into practical operation under his direction on the Baltimore and Ohio, and Liverpool and Manchester rail ways, in the early part of 1829, in connexion with friction wheels, for which friction wheels a patent was granted him in October, 1828. That these gudgeons were exhibited by him in England in 1829, and were adopted there without his deriving any advantage therefrom, as by the laws of that country, he could not secure the invention by patent, after having publicly exhibited it.

He then states, that the object of the invention, and a practical demonstration of its utility having been shown, its application and adaptation to the different rail road carriages, burthen wagons, locomotive engines, &c., and to the different bearing boxes that may be preferred for different purposes, (either revolving or common,) will be evident and easy to any person acquainted with the building of rail way carriages. But to render it still more so, the following general directions and proportions are given, which he thinks will be found to be a near approximation to what will be required in practice. He then states the general size of the axles and gudgeons which he would recommend for a given weight of load—and that the axles extend through and beyond the naves of the wheels on each side far enough to go under and receive the side frame of the load-bed—on the four gudgeons thus formed, the carriage body rests by means of any hard metal bearings attached to the side pieces, which side pieces are so framed with the cross pieces of the bed as to go on the outside of the wheels, either over or under the gudgeons as convenience may require. The friction occasioned by the tendency to a lateral movement of the gudgeon is limited by causing the end cover of the bearing to meet the end of the gudgeon as near to the centre of action as possible. When the revolving box is used, this end is attained by forming the end perfectly square, and when the common box is used, by forming the end of the gudgeons convex or rounding. In consequence of the small extent of bearing surface, the bearing box should be made as hard as the use of the most favorable materials for that purpose would permit. He then speaks of oiling the gudgeons and of preventing the oil working out, by turning one or two small rings or grooves on a portion of the axle between the gudgeon and the nave of the wheel. He then states that he does not intend to claim all merely projecting axles beyond, or external to, the wheels—and alludes to several of a different construction, either having a single wheel, or having a separate axle for each wheel, or one made subsequent to his invention for a temporary object, and not effecting the

like purpose, and that his invention is sufficiently distinguished from others by the new and useful effect produced in manner aforesaid. He then sums up his claim as follows:

"I therefore declare, that the improvement or improvements, above explained and described, in diminishing the resistance to motion in wheeled carriages to be used on rail ways, which I claim as my own invention, is the extending the axles each way outside of a pair or pairs of wheels, far enough to form external gudgeons to receive the bearing box of the load body, and diminished as aforesaid, with a view to lessen the resistance of friction, as small as its situation, with the use of the most favorable metal for wear, will permit. Thus conveniently increasing the leverage of the wheels, without impairing their effective strength and durability."

The defendants pleaded the general issue, and filed a specification of the various grounds of defence on which they relied—and among others, that the invention claimed was not new, but was, before the supposed discovery thereof, described in various printed publications, especially in Edgeworth on roads and carriages, where he describes the Irish car, with outside bearings, the axle turning with the wheels.

The plaintiff admitted that carriages with *out side bearings*, were in use before his invention, but he contended that by the specification annexed to his patent, he claimed simply the *application* of such outside bearings with diminished journals to rail road carriages.

The Court, however, decided, first, that he did not claim the *application* merely to rail road carriages, as appears by the title of his patent and the first clause in his specification, and secondly, that if he claimed merely such application, it could not be allowed, for it has repeatedly been decided that the application of an old invention to a new purpose, without any new contrivance or machinery, was no ground for a patent; and that if a patent, under these circumstances, could be sustained at all, it must be for the new mode of construction and new machinery by which the old invention was so applied—which new construction and machinery must be particularly specified. Here the plaintiff claimed generally the extending the axles each way outside of a pair or pairs of wheels far enough to form external gudgeons, and diminished with a view to lessen the resistance of friction. It being admitted that such mode of constructing axles had been before used in other carriages, the mere application of the same to rail road carriages was no ground for a patent.

This point being decisive of the cause, the other points of defence, viz: that the plaintiff was not the original inventor even as applied to rail road carriages, and that if he had been, he had abandoned the same to the public, and that the same had been in use by others for more than two years prior to granting the patent, were not discussed or considered.

GLEANINGS FROM FOREIGN JOURNALS.—No. III.

On a Remarkable Photographic Process, by Sir John Herschel.—If nitrate of silver, specific gravity 1.200, be added to ferro-tartaric

acid, specific gravity 1.023, a precipitate falls, which is in great measure redissolved by a gentle heat, leaving a black sediment, which being cleared by subsidence, a liquid of a pale yellow color is obtained in which a further addition of the nitrate causes no turbidness. When the total quantity of the nitrated solution added amounts to about half the bulk of the ferro-tartaric acid, it is enough. The liquid so prepared does not alter by keeping in the dark. Spread on paper and exposed *wet* to the sunshine (partly shaded) for a few seconds, no impression seems to have been made, but by degrees, although withdrawn from the action of the light, it developes itself spontaneously, and at length becomes very intense. But if the paper be thoroughly dried in the dark, (in which state it is of a very pale greenish yellow color,) it possesses the singular property of receiving a dormant, or invisible picture; to produce which (if it be, for instance, an engraving that is to be copied,) from thirty seconds to a minute's exposure in the sunshine is requisite. It should not be continued too long, as not only is the ultimate effect less striking, but a picture begins to be *visibly* produced, which darkens spontaneously after it is withdrawn. But if the exposure be discontinued before this effect comes on, an invisible impression is the result, to develope which all that is necessary is to breathe upon it, when it immediately appears, and very speedily acquires an extraordinary intensity and sharpness as if by magic. Instead of the breath, it may be subject to the regulated action of aqueous vapor, by laying it in a blotting paper book, of which some of the outer leaves on both sides have been damped by holding it over warm water.

Barometric Compensating Pendulum.—In 1825, Dr. Robinson of Armagh, by comparing the rate of the transit clock of his observatory with the indications of the barometer, found that there was an effect decidedly due to the varying density of the air. To remedy this he attached a barometer tube to the pendulum, so adjusted as to increase the time of vibration, by removing a cylinder of mercury further from the axis of the pendulum, as much as the diminished density of the air would have increased the same time. A fall of 1.6 of an inch in the barometer last year, produced a perceptible change of arc in the pendulum.

Classification of Waves.—Mr. Scott Russell classifies waves into four orders: first, the wave of translation, solitary in its character; second, waves of oscillation; third, capillary waves; fourth, corpuscular waves; all these latter are gregarious. The velocity in the first order of waves is dependent on their height and the depth of the fluid; each particle of water describes a semi-circle or a semi-ellipse, and then comes to rest, all the particles throughout the depth suffer the same amount of horizontal translation. The velocity in the second order depends upon the length of the wave alone; the particles of water describe curves returning into themselves, there is no permanent translation and the effects extend to moderate depths only beneath the surface.

Determination of the index error of an astronomical circle.—Dr. Robinson of Armagh effects this as follows. Illuminate the lines in the focus of the telescope behind, so as to leave the field dark. The rays from the lines emerge parallel through the object glass, and if reflected back from a surface of mercury, will form an image of the lines which will be visible through the eye piece with the lines themselves. If the declination line be made to coincide with its image, the optical axis will be vertical. This method is found to be certain and so easy that the index correction is generally determined at Armagh, at the close of each night's work.

Self-registering Meteorological Instruments.—The electro-magnetic meteorological register, constructed for the Observatory of the British Association, is nearly complete. It records the indications of the barometer, the thermometer, and the psychrometer every half hour during day and night, and prints the results, in duplicate, on a sheet of paper in figures. It requires no attention for a week, during which time it registers 1,008 observations. Five minutes are sufficient to prepare the machine for another week's work, that is, to wind up the clock, to furnish the cylinders with fresh sheets of paper, and to recharge the small voltaic element. The range of each instrument is divided into 150 parts; that of the barometer comprises three inches, that of the thermometer includes all degrees of temperature between $-5°$ and $+95°$, and the psychrometer has an equal range. The machine consists essentially of two distinct parts: the first is a regular clock, to which is attached all the requisite recurring movements; the second is a train, having an independent maintaining power, which is brought into action at irregular periods of time, by the contact of the plunging wires with the mercury of the instruments, as will be hereafter explained. The principal regularly recurring actions connected with the clock train are two: 1st. The plungers are gradually and regularly raised in the tubes of the instruments during five minutes, and are allowed to descend during one minute; 2nd. A type wheel, having at its circumference 15 figures, is caused to advance a step every two seconds, while another type wheel, having twelve spokes, but only ten figures, is caused to advance one step when the former completes a revolution. The complete revolution of the second type wheel is effected in six minutes, that is, in the same time occupied by the ascent and descent of the plungers. Thus every successive division of the range of an instrument corresponds with a different number presented by the two type wheels, the same division always corresponding with the same number. The two blanks of the second type wheel are presented during the return of the plungers, which occupies a minute, and during which time no observation is recorded. The breaking of the contact between the plunger and the mercury in an instrument, obviously takes place at a different position of the type wheels, according as the mercury is at a different elevation; if, therefore, the types be caused to make an impression at this moment, the degree of elevation of the mercury will be recorded. This end is thus effected. One

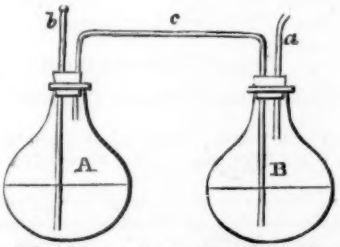
end of a conducting wire is connected with the mercury in the tube of the instrument, and the other end with the brass frame of the clock, which is in metallic communication with the plunger. In the course of this circuit an electro-magnet, and a single, very small, voltaic element are interposed. The electro-magnet is so placed as to act upon a small armature of soft iron connected with the detent of the second movement. So long as the plunger is in the mercury the armature remains attracted, but at the moment the plunger leaves the mercury the attraction ceases, and the release of the detent causes a hammer to strike the types, and impress them by means of black copying paper on the cylinder. The armature subsequently remains unattracted until the plunger descends. Immediately before it reascends, a piece of mechanism, connected with the clock movement, brings the armature into contact with the magnet, which remains there, in consequence of the recompletion of the circuit, until the contact is again broken.

Magnetic observations by the Antartic Expedition.—The following conclusions are drawn, by Sir John Herschel, from the observations made by Capt. Ross, and his officers, in the Antartic expedition: 1st. As great discordances are to be looked for, and must frequently be experienced in magnetic surveys conducted on land, as in those at sea, and even greater. In effect, the chief and worst cases of discordance occur in observations made on islands. 2nd. The general form of the curves of higher inclination in the southern hemisphere is much more analogous to that in the northern, than appears in M. Gauss' maps. 3rd. Capt. Ross' observations of intensity lead also to the conclusion of a much closer analogy between the two hemispheres, than M. Gauss' maps would appear to indicate. No higher intensity than 2.1 has been anywhere observed. 4th. In examining the observations of declination, particularly those which point out the course of the lines of 0° and 10° east, a more westerly position is indicated than that assigned by M. Gauss for the spot in which all the lines of declination unite.

Apjohn's formula for connecting the evaporating point, and the dew point.—Dr. Apjohn has applied three different experimental tests to this formula, and now gives a fourth. He shows that the elastic force of vapor in air, of any temperature, is connected, by a simple formula, with the temperature, an assumed volume of air, and the weight of vapor, of which the maximum of tension corresponds to the elastic force just referred to, in that volume of air; so that if the last named quantity be determined experimentally, the first named may be found. By passing moist air, of known volume and temperature, through suitable tubes containing chloride of calcium and asbestos, moistened with sulphuric acid, the weight of the vapor was ascertained, and the tension thence calculated was found to agree with that inferred from the formula, connecting the indications of the wet and dry bulb thermometers in the same air.

Method of determining the commercial value of alkalis, &c.—This method is proposed by Dr. Will, of Giessen:—"The apparatus by which this determination is effected, consists of two small glass

flasks, A and B, connected by the bent tube *c*, which passes through corks in the necks of the flasks. Into the flask A, is put the solution of the substance to be tried, and into B, is put concentrated sulphuric acid. Two other tubes pass through the corks in the flasks—the one, passing through the cork of A, dips below the surface of the solution, and is closed with a small piece of wax, while the one in B, is left open, and does not reach below the fluid contained in it. Suppose the flask A to contain a weighed quantity of a solution of a carbonate, then a known quantity of sulphuric acid is introduced into B, and the whole apparatus weighed; the tube *b*, being then closed with wax, if air be blown into *a*, a portion of the sulphuric acid passes over through the tube *c*, into the flask A, and comes in contact with the carbonate. The consequence is an evolution of carbonic acid, which must go through the concentrated sulphuric acid, and is thus made perfectly dry. When all the carbonate is decomposed, the piece of wax on the tube *b* is removed, and air sucked through the tube *a*, in order to remove all the carbonic acid. The apparatus is then to be weighed, and, from these data, the quantity of alkali combined with carbonic acid, may be easily calculated. The same method is applicable to the acids, particularly to vinegar, which was till now a very tedious, and, at the same time, a very inaccurate operation. Dr. Will considers that the value of soda, or potash, can be thus determined with much greater accuracy than according to the method of Descroizell, improved by Gay-Lussac."



Möser's images.—Mr. Hunt gives the following experiments upon these images:

"Three flat bottles, manufactured for Mr. Hunt's experiments on the influence of light on plants, were carefully prepared with three differently colored fluids. An intense solution of carmine in ammonia, which admitted the permeation of the red rays only; a strong solution of the sulphate of chromium, through which but a portion of the most refrangible red and the orange and yellow rays only passed; and the ammonia sulphate of copper, which absorbed all but the most refrangible portion of the spectrum. Thus were obtained the means of isolating, with a tolerable degree of purity, the calorific, the luminous, and the chemical spectra. Having several designs cut out of white paper, these were placed on copper plates, and being covered with the above bottles of fluids, placed in the sunshine. After remaining exposed for different periods at different times, from half an hour to three hours, they were brought from the light, and the plates

placed in the mercurial vapor box, and subjected to its influence. In no instance did any impression appear on the plates which were placed under the blue or yellow fluids, but in every case most decided impressions on those plates which were subjected to the influence of the red rays. Indeed, in some cases the impressions were beautifully visible without the use of mercurial vapor. It does, therefore, appear, when we take into consideration besides the above facts, also the fact which has been admitted, that artificial heat, at least, accelerates this molecular change, that an amount of evidence has been obtained in favor of the hypothesis of calorific disturbance, superior to the supposed evidences in favor of the absorption and radiation of any other solar emanation. From another series of experiments made with washed and unwashed plates, Mr. Hunt concluded that organic matter is not the cause of these images; but that the effect is due either to some disturbance of the latent caloric, which produces a molecular change, or to a thermo-electrical action, which it is difficult to understand. Had the effect been due, as M. Fizeau has stated, to slight layers of organic matter of a volatile nature, it appears natural to suppose that these mysterious images would have been found only on the very surfaces of the plates. Now, this is far from being the case. These images are often found to be impressed to a great depth into the metal. Mr. Hunt, in many cases, removed several surfaces of copper, and yet had been able to revive the images. He possessed copper plates rendered useless by the impressions, which he has in vain endeavored to remove."

Lunar Occultations.

Computed from the Elements published with the Occultation list of the United States Almanac.

Im. for Immersion, Em. for Emersion. These abbreviations in *Italics* refer to those Immersions and Emersions which take place on the Moon's dark limb. N. App. for Near Approach.

The angles are for *inverted image*, or as seen in an astronomical telescope, and reckoned from the Moon's North point and from its Vertex around through East, South, West, to North again. For direct vision add 180°.

JANUARY, 1844.

Day.	H'r.	Min.	Star's name.	Mag.	From North.	From Vertex.
1	9	11	*Im.* 32 Tauri,	6	221°	217°
1	10	23	Em		115	74
1	17	29	*Im.* 463 Bailey,	7	254	213
1	18	16	Em.		107	72
9	11	0	Im. p^1 Leonis,	6	317	6
9	12	2	*Em.*		100	145
12	12	54	Im. 85 Virginis,	6	259	305
12	13	43	*Em.*		44	89
21	5	47	*Im.* Bessel,	9	266	222
21	6	49	Em.		89	348
22	6	3	*Im.* Bessel,	9	243	200
22	7	11	Em.		61	14
22	6	22	*Im.* Bessel,	9	276	232
22	7	12	Em.		28	340
22	7	55	*Im.* Bessel,	8	160	110
22	8	2	Em.		149	100

LUNAR OCCULTATIONS FOR JANUARY, 1844,—CONTINUED.

Day.	H'r.	Min.	Star's name.	Mag.	From North.	From Vertex.
22	13	29	*Im.* Bessel,	9	178	128
22	13	59	Em		135	85
23	4	1	*Im.* Bessel,	9	260	238
23	5	45	Em.		36	2
24	8	45	*Im.* 45 Piscium,	6	313	262
24	9	14	Em.		3	313
25	5	7	*Im.* Bessel,	8	297	293
25	5	56	Em.		4	343
25	7	1	*Im.* Bessel,	9	257	215
25	8	19	Em.		57	8
29	6	24	*Im.* v^1 Tauri,	5	249	73
29	7	56	Em.		291	65
29	7	14	*Im.* v^2 Tauri,	6	238	257
29	8	39	Em.		109	61
29	16	47	*Im.* τ Tauri,	5	196	153
29	16	58	Em.		170	128
31	3	58	*Im.* 759 Bailey,	6.7	288	356
31	4	53	Em.		56	112
31	6	57	*Im.* u Geminorum,	4.5	224	142
31	7	53	Em.		265	185
31	15	5	N.App.15 Gemin. ☽ S 0.′7	6		
			FEBRUARY, 1844.			
2	5	32	*Im.* 3 Cancri,	6	261	314
2	6	25	Em.		107	161
5	15	52	Im. u Leonis,	6	272	239
5	16	54	*Em.*		149	107
5	16	29	Im. 57 Leonis,	7	308	256
5	17	37	*Em.*		112	66
6	17	46	Im. *B.* Virginis,	6	256	215
6	18	36	*Em.*		158	113
7	10	59	Im. *q* Virginis,	5.6	321	99
7	11	53	*Em.*		6	139
21	6	25	*Im.* Bessel,	9	171	121
21	6	41	Em.		145	96
22	5	51	*Im.* Bessel,	9	276	230
22	7	2	Em.		45	355
22	6	58	*Im.* 104 Piscium,	6.7	276	225
22	8	3	Em.		51	359
22	7	42	*Im.* Bessel,	9	301	249
22	8	48	Em.		29	336
22	9	33	*Im.* Bessel,	9	251	201
22	10	29	Em.		84	36
23	6	0	*Im.* Bessel,	9	289	243
23	7	21	Em.		62	10
23	9	30	*Im.* Bessel,	8	329	276
23	9	53	Em.		13	321
23	4	39	N.App. χ Arietis, ☽ N.1′.5	6		
24	10	43	*Im.* τ^2 Arietis,	7	233	180
24	11	33	Em.		120	71
24	11	36	*Im.* 65 Arietis,	6	220	170
24	12	13	Em.		134	87
25	4	50	Im. A^1 Tauri,	5	275	248
25	6	20	Em.		64	39
25	5	38	*Im.* A^2 Tauri,	6.7	304	304
25	6	46	Em.		38	3
25	10	27	*Im.* 463 Bailey,	7	222	166
25	11	9	Em.		142	88
27	12	22	*Im.* Q^2 Tauri,	6	209	154
27	12	39	Em.		176	121

METEOROLOGICAL OBSERVATIONS FOR SEPTEMBER, 1843.

Moon.	Days.	Therm. Sun Rise.	Therm. 2 P.M.	Baromtr. Sun Rise.	Baromtr. 2 P.M.	Wind. Direction.	Wind. Force.	Water Fallen in rain	State of the Weather, and Remarks.	
☾	1	74°	75°	29.90	29.94	E.	Moderate		Cloudy.	Cloudy
	2	67	78	29.95	29 95	NE.	do		Cloudy.	Cloudy.
	3	72	84	29.84	29.80	W.	do		Cloudy.	Lightly cloudy.
	4	74	86	29.74	29.75	SW.	do	.30	Par. cloudy.	Clear—rain.
	5	70	82	29.80	29.90	NE.	do		Cloudy.	Clear.
	6	70	75	30.05	30.05	NE.	do		Cloudy.	Cloudy.
	7	66	64	30.00	29.95	NE.	do	1.20	Rain.	Rain.
⊙	8	62	68	30.00	30.00	NE.	do		Cloudy.	Cloudy.
	9	62	68	29.90	29.95	NW.	do		Clear.	Clear
	10	56	62	30.10	30.09	N.	do		Cloudy.	Clear.
	11	50	52	29.90	29.90	NE.	do	1.52	Rain.	Rain.
	12	52	63	29.93	29.96	E.W.	do		Par. cloudy.	Flying clouds.
	13	52	66	30.06	30.10	NE.	do		Clear.	Par. cloudy.
	14	56	63	30.10	30 06	NE.	do	1.00	Clear.	Rain.
	15	71	76	29.80	29.72	S.SW.	Brisk		Cloudy.	Par. cloudy.
	16	67	76	29.82	29.88	W.	Calm		Clear.	
	17	72	68	29.90	29.95	W.	Moderate		Fog.	Clear.
	18	70	84	29.98	29.90	W.	Calm		Fog.	Clear.
	19	71	84	30.00	30.06	SW.	Moderate		Clear.	Clear.
	20	65	79	30.17	30.20	NE.SE	do		Clear.	Flying clouds.
	21	64	81	30.03	29.88	S.E.	Brisk		Clear.	Par. cloudy.
	22	71	72	29.88	29.88	W.E.	Calm		Par. Cloudy.	Clear.
⊗	23	61	74	29.91	29.88	S.	Moderate		Cloudy.	Clear.
	24	72	82	29.85	29.82	W.	do		Cloudy.	Clear.
	25	71	84	29.77	29.73	W.	Brisk		Clear.	Par. cloudy.
	26	70	63	29.65	29.68	E.	Moderate	.16	Rain—cloudy.	Rain.
	27	48	54	29.93	29.95	NW.	Brisk	.70	Cloudy.	Clear.
	28	40	59	30.07	30.06	W.	Moderate		Clear.	Lightly cloudy.
	29	50	65	30.03	29.99	SW.	do		Par. cloudy.	Clear.
☽	30	49	64	30.05	20.03	SE.	do		Par. Cloudy.	Clear.
		63.17	71.70	29.94	29.93			4.88		

Thermometer. Max. 86.00, on 4th. Min. 40.00, on 28th. { Mean, 67.435

Barometer. Max. 30.20 on 20th. Min. 29.65 on 26th. { Mean 29.93

OCTOBER, 1843.

	1	57°	65°	29.79	29.67	SE.	Calm	.18	Rain.	Rain.
	2	62	70	29.58	29.58	W.	Brisk		Hazy.	Clear.
	3	56	60	29.56	29.51	W.	Blusteri'g		Clear—fly. clds.	Showery.
	4	48	59	29.46	29.70	W.	do	.03	Clear—fly. clds.	Clear.
	5	44	62	29.92	29.92	W.	Brisk		Clear.	Clear.
	6	48	68	29.88	29.80	S.	Calm		Clear.	Clear.
	7	58	62	29.67	29.56	E.	Moderate		Rain.	Rain.
⊙	8	74	58	29.45	29.43	W.	do	1.98	Rain.	Rain.
	9	41	54	29.68	29.54	SW.	do		Clear.	Clear.
	10	47	60	29.58	29 60	W.	Brisk.		Flying clouds.	
	11	46	62	29.75	29.75	W.	Calm		Clear.	Clear.
	12	52	68	29 75	29.72	SW.	Moderate		Cloudy.	Clear.
	13	44	55	29.86	29.78	SW.	do		Clear.	Clear
	14	39	50	29 93	30.02	W.	Brisk		Clear.	Clear.
	15	40	52	30.09	30.03	SW.	Calm		Clear.	Cloudy.
☽	16	47	56	29.82	29.74	NE.	Moderate		Par. cloudy.	Cloudy.
	17	38	49	29.75	29.75	NE.	Brisk		Clear	Cloudy.
	18	38	56	29.79	29.74	SW.	Moderate		Clear.	Clear.
	19	44	52	29.83	29.90	W.	Brisk		Clear.	Par. cloudy.
	20	38	62	29.92	29.95	SW.	do		Clear.	Clear.
	21	32	68	29.70	29.68	S.	Calm		Clear.	Clear.
	22	56	55	29.55	29.56	SW.	Moderate	.68	Clear—cloudy.	Rain.
⊗	23	48	45	29.80	29.83	NW.	Brisk		Clear.	
	24	36	50	30.00	29.95	W.	Moderate		Clear.	Clear.
	25	45	54	29.82	29.74	SW.	do		Cloudy.	Cloudy.
	26	44	45	29.92	29.85	NE.	do		Cloudy.	Cloudy.
	27	43	48	29.83	29.45	E.	do	.50	Rain.	Cloudy.
	28	37	49	29.97	29.86	NW.	do		Cloudy.	Clear.
☾	29	37	49	29.80	29.93	W.	Calm		Cloudy.	Clear.
	30	41	52	30.04	30.00	SW.NW.	Moderate		Cloudy.	Clear.
	31	32	43	30.10	30.13	NW.N.	do		Clear.	Clear.
		45.29	56.06	29.80	29.79			3.37		

Thermometer. Maximum 74.00 on 8th. Minimum 32.00 on 21st & 31st. { Me'n 50.675

Barometer. Max. 30.13 on 31st. Min. 29.43 on 8th. { Mean, 29.795